6/1/94-01760

Final

Risk Evaluation
Site 5
Surplus Transformer Storage Area

Naval Weapons Station Yorktown
Yorktown, Virginia

Prepared For

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command

Norfolk, Virginia

Under The

LANTDIV CLEAN Program

Comprehensive Long-Term Environmental Action Navy

Reference:
Contract
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Baker
Baker Environmental, Inc.

FOSTER WHEELER
FOSTER WHEELER ENVIRESPONSE, INC.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

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FINAL

RISK EVALUATION

SITE 5
SURPLUS TRANSFORMER STORAGE AREA

NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINIA

CONTRACT TASK ORDER 0209

JUNE 3, 1994

Prepared for:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

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LIST OF ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COPC	Chemical of Potential Concern
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CSF	Carcinogenic Slope Factor
FFA	Federal Facilities Agreement
HEAST	Health Effects Assessment Summary Tables
IAS	Initial Assessment Study
ICR	Incremental Cancer Risk
IRIS	Integrated Risk Information System
kg	Kilogram
LOAEL	Lowest-Observed-Adverse-Effect-Level
MF	Modifying Factor
mg/day	milligram per day
mg/kg	milligram per kilogram
NEESA	Naval Energy and Environmental Support Activity
NOAEL	No-Observed-Adverse-Effect-Level
NOEL	No-Observed-Effect-Level
PCB	Polychlorinated Biphenyl
ppm	Parts Per Million
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RfD	Reference Dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
TAL	Target Analyte List
TCDD	Tetrachlorodibenzo-p-dioxin
TCL	Target Compound List
TSCA	Toxic Substances Control Act
UF	Uncertainty Factor
USEPA	United States Environmental Protection Agency
WPNSTA Yorktown	Naval Weapons Station Yorktown, Yorktown, Virginia

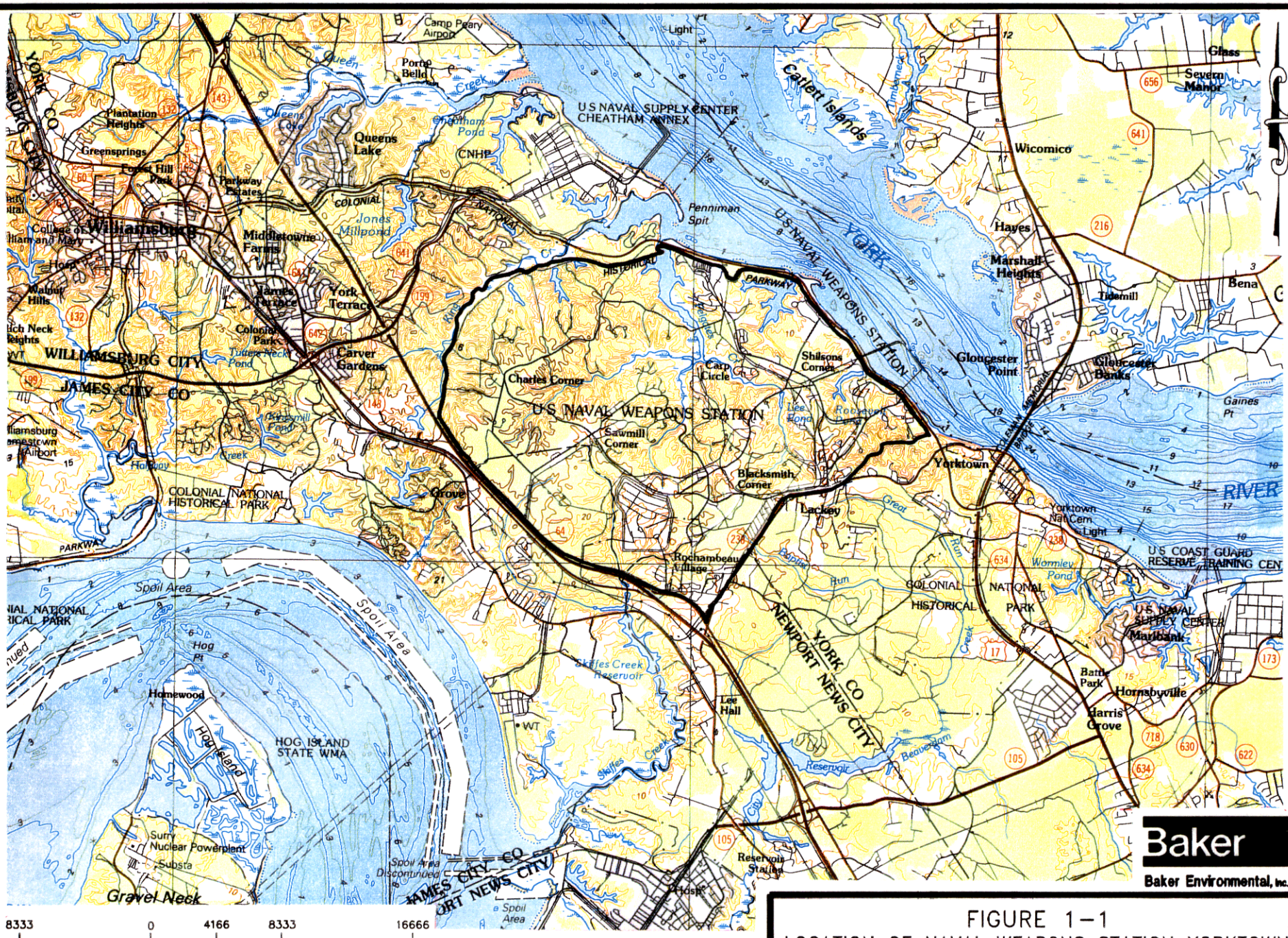
1.0 INTRODUCTION

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Federal Facilities Agreement (FFA) for Naval Weapons Station Yorktown, Yorktown, Virginia (WPNSTA Yorktown), each identified hazardous waste site must undergo an evaluation of risk. This risk evaluation was performed to identify whether further remedial action should be taken at a site. This report presents the risk evaluation for potential human exposure to the Surplus Transformer Storage Area, Site 5. Consistent with the WPNSTA Yorktown Draft FFA 1994, a risk evaluation was conducted instead of the standard baseline risk assessment with the permission of United States Environmental Protection Agency (USEPA) Region III. The decision to conduct the risk evaluation was based on the limited size of Site 5 and the nature and extent of contamination. The purpose of the sampling activities conducted at the Surplus Transformer Storage Area, Site 5, under the recent Remedial Investigation (RI), was to determine the success of a previous removal effort and further define the vertical and horizontal extent of potential polychlorinated biphenyl (PCB) contamination in soils to support a no action decision. A complete Target Compound List (TCL)/Target Analyte List (TAL) analyses was not performed because only PCBs were identified as chemicals of potential concern (COPCs), based on site history (i.e., PCB transformers were stored at the site) and previous investigation results. Since this building is not currently in use, only future (potential) land-use scenarios were assessed for the site considering no further remedial action. If the results of this evaluation indicate no future (potential) risk, the no remedial action scenario will be recommended.

1.1 Station Description

WPNSTA Yorktown is a 10,624 acre installation located on the Virginia Peninsula in York and James City Counties and the City of Newport News (Figure 1-1). The installation is bounded on the northwest by the Naval Supply Center Cheatham Annex, the Virginia Emergency Fuel Farm and the future community of Whittaker's Mill; on the northeast by the York River and the Colonial National Historic Parkway; on the southwest by Route 143 and Interstate 64; and on the southeast by Route 238 and the community of Lackey.

WPNSTA Yorktown, originally named the U.S. Mine Depot, was established in 1918 to support the laying of mines in the North Sea during World War I. The establishment of the depot was the culmination of a search process, begun in 1917 at the request of Congress, to locate an Atlantic coast site for a weapons handling and storage facility. For 20 years after World War I, the depot received, reclaimed, stored, and issued mines, depth charges, and related materials. During World War II, the facility was expanded to



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SOURCE: U.S.G.S. 1:100,000–SCALE PLANIMETRIC MAP, WILLIAMSBURG, VIRGINIA, 1984.

FIGURE 1–1
LOCATION OF NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINIA

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include three additional trinitrotoluene loading plants and new torpedo overhaul facilities. A research and development laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the facility, which included the design and development of depth charges and advanced underwater weapons. On August 7, 1959, the U.S. Mine Depot was redesignated the U.S. Naval Weapons Station. The primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

1.2 Site Description

Site 5 is located near Barracks Road in the northeastern portion of the Station adjacent to the south end of Building 76. The area is approximately 1,000 square feet in size and is fenced. Two concrete pads are located within the fenced area; the remainder of the area is covered with gravel. The area was used from 1940 to 1981 as a storage area for surplus PCB-containing electrical transformers which were placed on end, around and on the two large concrete pads. After 1981, only non-leaking transformers were stored at this location. Currently, no transformers are stored at Site 5 and the building is deserted with areas surrounding the site primarily open or wooded.

An estimated 300 pounds of PCB-containing fluids were reported to have leaked from stored transformers. A cleanup effort was conducted in December of 1982 which included the removal of contaminated soils at Site 5. The amount of soil removed from the site is not known and confirmation sampling was not conducted at that time to determine the effectiveness of the removal action.

1.3 Document Organization

This document is separated into an additional eight sections as outlined below.

- Section 2.0 describes the basis for the selection of the COPCs.
- Section 3.0 discusses the potential fate and transport for COPCs.
- Section 4.0 presents the exposure assessment, which describes potential exposure scenarios for future land use.
- Section 5.0 presents the toxicity assessment, which contains an overview of the potential toxicological effects of the COPCs.

- Section 6.0 presents the risk characterization and describes those calculations used in the evaluation of potential human health risks in conjunction with site-specific chemical data.
- Section 7.0 discusses sources of uncertainty.
- Section 8.0 summarizes the findings of the risk evaluation.
- Section 9.0 provides a list of references.

2.0 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Chemicals of potential concern (COPCs) are defined as site-related chemicals used to qualitatively and quantitatively estimate the potential human and/or environmental effects that might occur subsequent to exposure. In this assessment, COPCs were selected according to site history and by evaluating both previously and recently collected environmental data. In addition, analytical results were compared to available environmental standards including the PCB criteria under the Toxic Substances Control Act (TSCA). Under TSCA [40 CFR 761.125(c)(4)(v) Requirements for decontaminating spills in nonrestricted access areas], PCB-contaminated soil that has been decontaminated to 10 parts per million (ppm) by weight (minimum depth of 10 inches) can be replaced with "clean soil" (i.e., containing less than 1 ppm PCBs).

2.1 Previous Findings

In 1984, an Initial Assessment Study (IAS) was conducted at WPNSTA Yorktown (C.C.Johnson & Associates, Inc. and CH2M Hill, 1984). The purpose of this study was to identify areas of sufficient threat to human health and/or the environment to warrant additional investigation. Site 5 was one of 15 sites recommended for further study from this evaluation. Following this recommendation, environmental data were collected during the first round of sampling at the 15 site; results were presented in the Round One Confirmation Study Report (Dames & Moore, June 1986). A second round of sampling for the Confirmation Study was also conducted, but Site 5 was not included (Dames & Moore, June 1988). In July 1991, an RI Interim Report (Versar, 1991) was submitted, which included a summary of the first round of sampling at Site 5 and also combined and summarized the data from the two Confirmation Study Reports for the other 14 sites investigated.

During the Confirmation Study, ten soil samples were collected at a depth of 0 to 12 inches and analyzed for PCB congeners and dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD]) at Site 5. These locations are presented in Figure 2-1 and the data are presented on Table 2-1. TCL/TAC analysis was not performed because only PCB transformers were stored at the site. No other activities occurred at the site which would warrant any other compounds to be tested. Only one congener of PCBs, Aroclor-1260, was detected in four of the ten samples collected. The detected results ranged from 0.242 to 1.920 milligrams per kilogram (mg/kg). The maximum detected concentration (1.9 mg/kg at location 5SO10) is approximately twice the TSCA "clean soil" concentration of less than 1 ppm (or 1 mg/kg). TCDD was not detected in any of the soil samples.

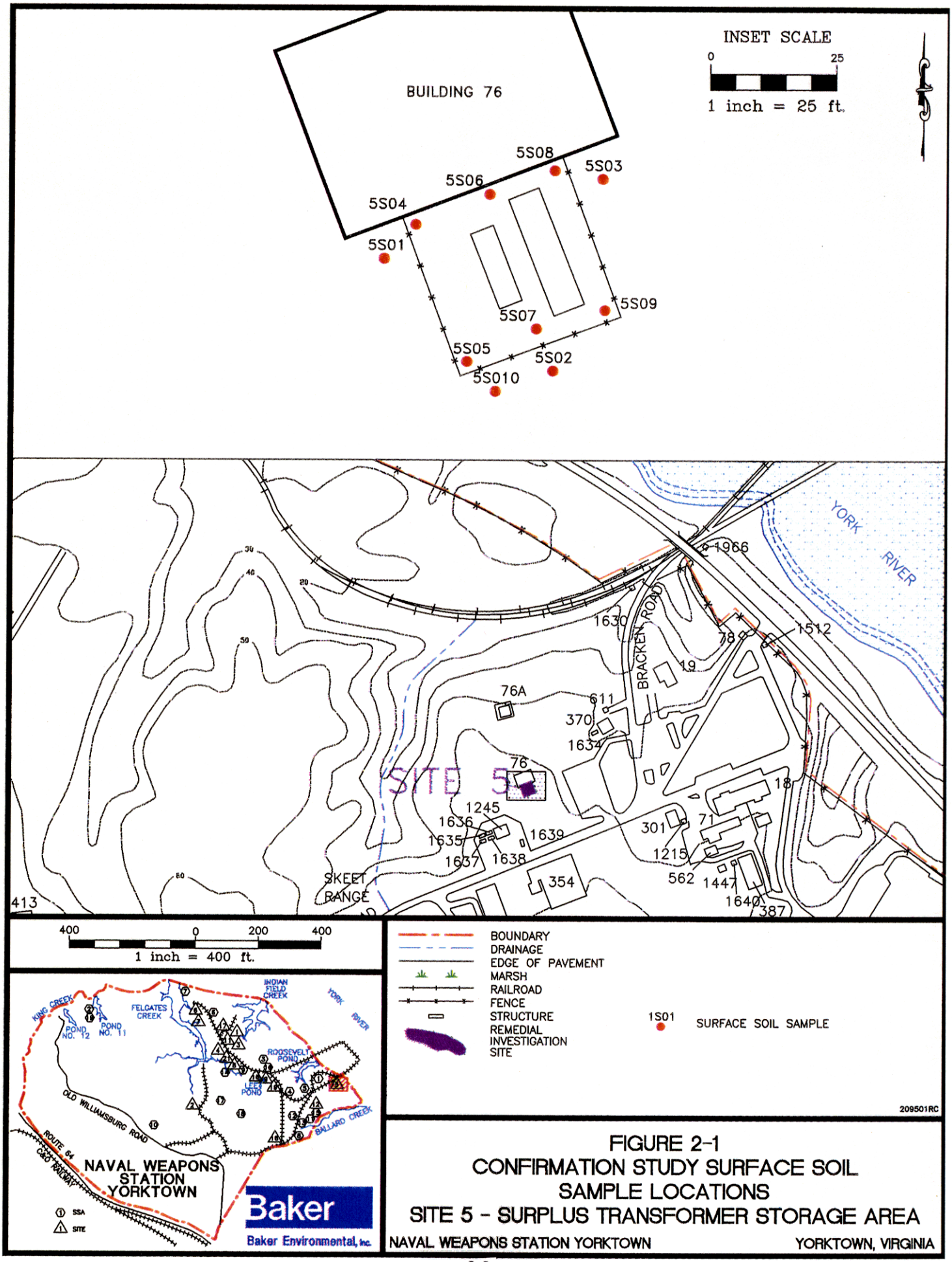

FIGURE 2-1
CONFIRMATION STUDY SURFACE SOIL SAMPLE LOCATIONS
SITE 5 - SURPLUS TRANSFORMER STORAGE AREA
NAVAL WEAPONS STATION YORKTOWN YORKTOWN, VIRGINIA

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TABLE 2-1

SOIL ANALYTICAL RESULTS OF CONFIRMATION STUDIES AT SITE 5
NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINIA

	Sample No.									
	5S01 (μg/kg)	5S02 (μg/kg)	5S03 (μg/kg)	5S04 (μg/kg)	5S05 (μg/kg)	5S06 (μg/kg)	5S07 (μg/kg)	5S08 (μg/kg)	5S09 (μg/kg)	5S010 (μg/kg)
Aroclor-1016	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Aroclor-1221	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Aroclor-1232	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Aroclor-1242	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Aroclor-1248	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Aroclor-1254	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Aroclor-1260	<10	<10	<10	550	<10	466	<10	242	<10	1920
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	<50	<50	*	*	<50	<50	<50	<50	<50	<50

Notes: ug/kg - micrograms per kilogram
<10 - Not detected at or above the detection limit of 10 μg/kg.
* - Interference

Source: Versar, 1991

2.2 Current Findings

In 1992, additional investigations were conducted at WPNSTA Yorktown. The results of these sampling efforts are presented in the Round One RI Report (Baker/Weston, 1993). The purpose of the sampling activities conducted at the Surplus Transformer Storage Area, Site 5, was to determine the success of the previous removal effort and further define the vertical horizontal extent or potential PCB contamination in soils. During the investigations at Site 5, 24 near-surface soil samples were collected and analyzed for TCL PCBs. Eighteen samples were collected at depths of 0 to 12 inches, including two duplicate samples; six were collected at depths of 12 to 24 inches. The sample numbers used were the same as the Confirmation Study numbering scheme. Samples were collected at the 12 to 24-inch depth to determine if PCB contamination was migrating beyond the 0 to 12-inch depth in three sample locations identified in the Confirmation Study as having the highest level of contamination and three other locations which would show horizontal migration.

In addition, two subsurface soil samples (0 to 12 inches and 9 to 10 feet) were collected from soil boring 5SB10 (10 feet in total depth) located just south of 5S010, where the highest detected value of PCBs was collected during the Confirmation Study. Four concrete chip samples also were collected from the concrete pads upon which the transformers had been stored to assess the extent of contamination within the concrete pad. Two of the surface soil sample locations (0 to 12 inches) were placed adjacent to each concrete pad next to the most stained concrete chip samples with the assumption that these locations would have the highest potential for elevated concentrations. Also, one groundwater sample was collected using a HydroPunch™ sampler also at the location of the highest value detected during the Confirmation Study (5S010). All of these samples were analyzed for TCL PCBs. Table 2-2 presents the results of this sampling and analysis effort and Figure 2-2 presents the locations from which these samples were collected.

Aroclor-1260 was detected in 17 of the 24 surface soil samples; however, other PCB congeners were not found. The maximum detected concentration was 1.4 mg/kg (at location 5S04), which is slightly greater than the TSCA "clean soil" concentration of less than 1 mg/kg. Aroclor-1260 also was detected above the TSCE "clean soil" concentration in one other sample with a detected concentration of 1 mg/kg (location 5S06). All other values were detected below 1 mg/kg. PCBs were not detected in either of the samples from the soil boring. Detectable concentrations of Aroclor-1260 were reported in two of the four concrete chip samples, but the levels were less than those detected in the soils. The groundwater sample collected from the HydroPunch™ sampler did not display detectable concentrations of PCBs.

TABLE 2-2

SOIL ANALYTICAL RESULTS OF ROUND ONE REMEDIAL INVESTIGATION AT SITE 5
NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINIA

Surface Soil Samples

Sample No.	Aroclor-1260 (µg/kg)
5S01-001	ND
5S02-001	ND
5S03-001	36J
5S04-001	1,400
5S04-002	54
5S05-001	36
5S06-001	1,000
5S06-002	950
5S07-001	34J
5S08-001	170J
5S08-002	16J
5S09-001	230J
5S09-101	150J
5S11-001	400J
5S11-002	ND
5S12-001	380
5S12-002	33J
5S13-001	570
5S13-002	17J
5S13-101	380
5S14-001	ND
5S15-001	ND
5S16-001	440J
5S17-001	70

Concrete Samples

Sample No.	Aroclor-1260 (µg/kg)
5C01-001	41J
5C02-001	ND
5C03-001	ND
5C04-001	12J

Soil Boring Samples

Sample No.	Aroclor-1260 (µg/kg)
5SB10-001	ND
5SB10-002	ND

HydroPunch™ Samples

Sample No.	Aroclor-1260 (µg/kg)
5HP10	ND

J = Estimated Value
ND = Not Detected
-001 = 0-12 inch sample depth
-002 = 12-24 inch sample depth
-101 = Duplicate 0-12 inch sample depth
µg/kg = micrograms per kilogram

Source: Baker/Weston, Final Round One RI Report, July 1993

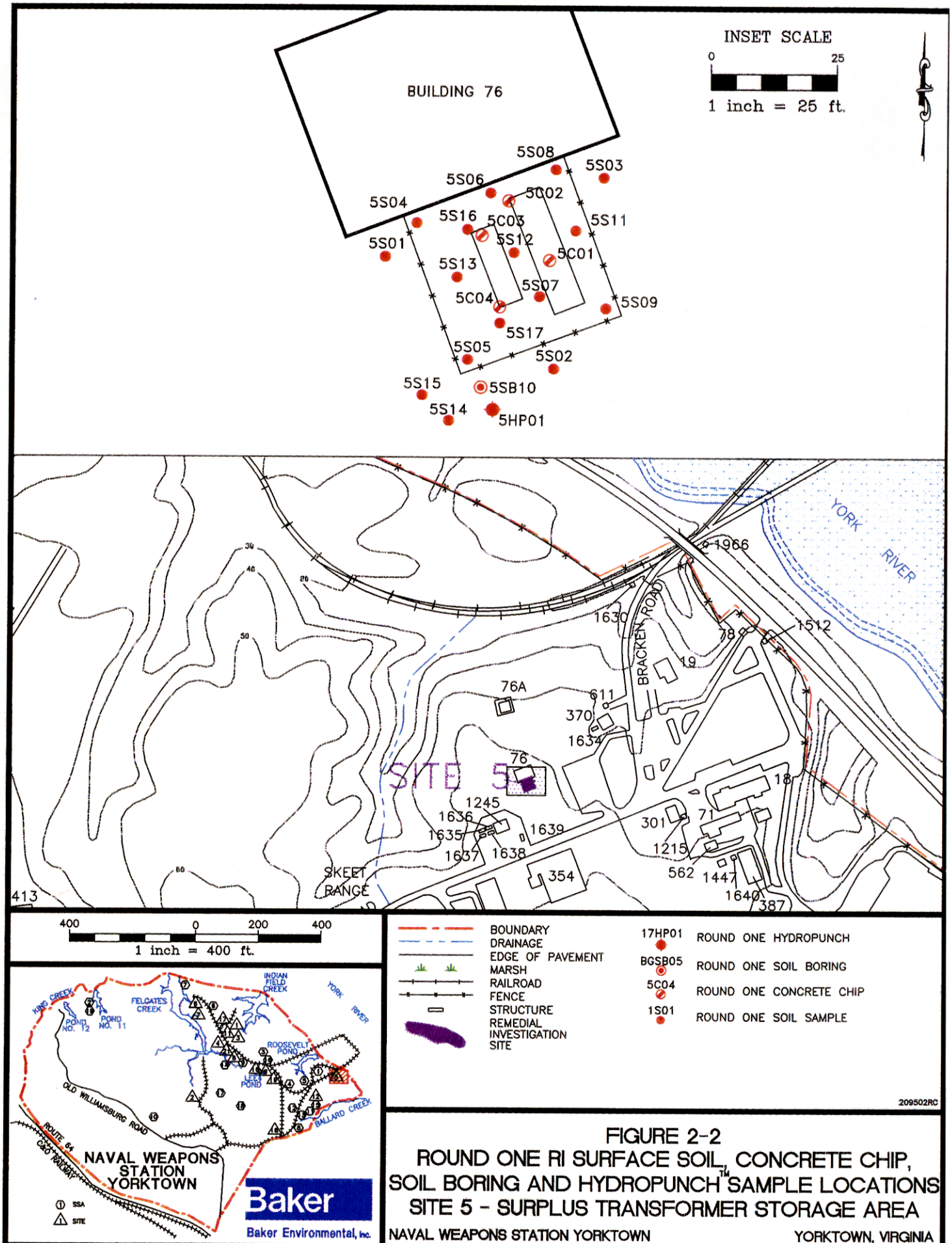

FIGURE 2-2
ROUND ONE RI SURFACE SOIL, CONCRETE CHIP, SOIL BORING AND HYDROPUNCH™ SAMPLE LOCATIONS
SITE 5 - SURPLUS TRANSFORMER STORAGE AREA
NAVAL WEAPONS STATION YORKTOWN YORKTOWN, VIRGINIA

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2.3 Chemicals of Concern at Site 5

Based on the site history, evaluating the results of previous and recently collected environmental data, and its prevalence in Site 5 soils, Aroclor-1260 was selected as the COPC to be evaluated in the risk evaluation. Since this compound was not detected in groundwater or subsurface soils, these media were not evaluated further. In addition, since concrete is not an environmental medium to which an individual could be chronically exposed, this medium also was not retained for the risk evaluation. Thus, PCBs detected in surficial soils (0 to 2 feet depth) were selected to be quantitatively assessed in this analysis.

Only the most recent analytical data were used in the quantitative assessment (Baker/Weston, 1993). The samples were analyzed in accordance with USEPA Contract Laboratory Program (CLP) methodologies for PCBs and validated according to the National Functional Guidelines, Naval Energy and Environmental Support Activity (NEESA) Level D requirements, and USEPA Region III guidelines. PCBs were selected based on site history, evaluation of previously and recently collected environmental data, and prevalence in Site 5 soils, which indicated Aroclor-1260 as the chemical of concern for this site.

3.0 FATE AND TRANSPORT OF PCBs

The term PCBs refers to a variety of mixtures of individual biphenyl isomers, each consisting of two "aromatic" six carbon rings and up to ten chlorine atoms. Mixtures of these isomers are known by their commercial designation of Aroclor, which is followed by a four-digit number. The first two numbers indicate the type of isomer mixture and the last two designate the approximate percent weight of chlorine in the mixture.

PCBs are environmentally persistent, man-made chemicals that were used as insulating materials in electrical transformers and electrical equipment and as lubricants. Because of their persistence and toxicity in the environment, their manufacture was discontinued in the U.S. in 1977. However, PCB equipment manufactured before 1977 is currently in use and regulated by the USEPA.

PCBs are very stable chemically and tend to persist in the environment. Persistence and bioaccumulation in living organisms also occurs due to the high lipophilicity (lipid and/or fat-loving characteristics) of these compounds.

Experimental data suggest that PCBs are strongly adsorbed to soils; their affinity increases with increasing chlorination of the mixture. PCBs adsorbed on soil or present in the soil mixture will be subject to ingestion if the contaminated area is accessible to children or to adults.

Degradation of PCBs in the environment is dependent upon the degree of chlorination. In general, the more chlorinated the PCB molecule, the more persistent it will be in the environment. Factors which determine biodegradability of PCBs include the amount of chlorination, concentration of PCBs, type of microbial populations, available nutrients, and temperature (USEPA, 1982).

Table 3-1 presents the pertinent physical-chemical data for the most common PCB mixtures, and Appendix A presents the toxicological profile for PCBs. From this information a quantitative assessment of mobility can be derived as follows:

TABLE 3-1

PHYSICAL/CHEMICAL PROPERTIES AND RELATIVE MOBILITY INDICES FOR SELECT POLYCHLORINATED BIPHENYLS

Constituent	Molecular Weight (g/mol)	Specific Gravity (g/cm^3)	Water Solubility (mg/L)	Vapor Pressure @ 25°C (mm/Hg)	log K_{oc}	log K_{ow}	Henry's Law Constant (atm m^3/g mol)	Mobility Index
Aroclor-1016	257.9	1.182	0.42	$4x10^{-4}$	5.26	4.38	NA	-9.03
Aroclor-1221	200.7	1.266	15.0	$6.7x10^{-4}$	3.77	4.08	NA	-5.77
Aroclor-1232	232.2	1.380	1.45	$4.06x10^{-3}$	2.89	4.54	NA	-5.12
Aroclor-1242	266.5	1.445	0.24	$4.06x10^{-4}$	3.80	5.58	$5.73x10^{-4}$	-7.8
Aroclor-1248	299.5	1.538	0.054	$4.94x10^{-4}$	5.75	6.11	$3.51x10^{-3}$	-10.3
Aroclor-1254	328.4	1.620	0.012	$7.71x10^{-5}$	5.51	6.03	$8.37x10^{-3}$	-12.1
Aroclor-1260*	377.8	1.646	0.0027	$4.05x10^{-5}$	6.30	7.15	$7.13x10^{-3}$	-14.1

*Chemical of Potential Concern (COPC)

Notes: K_{oc} = Organic carbon partition coefficient
K_{ow} = Octanol water partition coefficient
Mobility Index = Log (Water Solubility * Vapor Pressure/K_{oc})

USEPA. 1982. Aquatic Fate Process Data for Organic Priority Pollutants. Final Report. Office of Water Regulations and Standards. 440/4-81-014.

$$MI = \log(S*VP/K_{oc})$$

Where: MI = Mobility Index
S = Water solubility
VP = Vapor pressure
K_{oc} = Organic carbon partition coefficient

Ford and Gurba (1984) have developed a relative scale by which mobility indices can be evaluated.

MI	Description
>5	Extremely mobile
0 to 5	Very mobile
-5 to 0	Slightly mobile
-10 to 0	Immobile
<-10	Very immobile

Material that are strongly adsorbed to soils are considered to have a low MI. For PCBs, water solubility and vapor pressure directly impact MIs. Water solubility and vapor pressure decrease with increasing chlorine contact. MIs for PCBs range from immobile (Aroclor-1232) to very immobile (Aroclor-1260). Thus, at Site 5, the PCBs detected would not be expected to migrate from the soils in which they currently are present.

4.0 TOXICITY ASSESSMENT

A toxicological evaluation characterizes the inherent toxicity of a compound and contains a review of available scientific data to determine the nature and extent of the potential human health and environmental effects associated with potential exposure to a chemical. An important component of the evaluation is the relationship between the dose of a compound (amount to which an individual or population is potentially exposed) and the potential for adverse effects resulting from exposure to that dose. Standard reference doses (RfDs) and/or carcinogenic slope factors (CSFs) have been developed for a variety of chemicals, including PCBs, to assess this dose-response relationship.

An RfD is developed for chronic and/or subchronic human exposure to chemicals and is based solely on the noncarcinogenic effects of chemical substances. It is defined as an estimate of the daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of adverse effects during a lifetime. An RfD is usually expressed as dose (mg) per unit body weight (kg) per unit time (day). An RfD is generally derived by dividing a No-Observed-(Adverse)-Effect Level (NOAEL or NOEL) or Lowest-Observed-Adverse-Effect-Level (LOAEL) for a critical toxic effect by an appropriate "uncertainty factor (UF)."

Uncertainty factors usually consist of multiples of 10, where each factor represents a specific area of uncertainty present in the extrapolation process. The uncertainty factors presented below were extracted from the Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual, Part A (USEPA, 1989). A UF of 10 is used:

- To account for variation in the general population and is intended to protect sensitive subpopulations (e.g., elderly, children).
- When extrapolating from animals to humans and is intended to account for the interspecies variability.
- When a NOAEL from a subchronic study is used as the basis for a chronic RfD.
- When a LOAEL is used and is intended to account for the uncertainty in extrapolating from LOAELs to NOAELs.

A Modifying Factor (MF) ranging from >0 to 10 also is applied to the RfD. This MF is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire database, not specifically addressed by the preceding uncertainty factors. The default value for the MF is 1. Thus, the RfD incorporates the certainty of the evidence for chronic, noncarcinogenic human health

effects. Even if applicable human data exist, the RfD still maintains a margin of safety so that chronic human health effects are not underestimated.

CSFs are used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen (USEPA, 1989). This factor is derived through an assumed low-dosage, linear, multi-stage model and an extrapolation from high to low dose responses determined from animal studies; CSFs are generally reported in units of $(mg/kg\text{-}day)^{-1}$. The value used in reporting the slope factor is the upper 95th percent confidence limit, which means that there is reasonable confidence that the carcinogenic potency of a chemical will not be underestimated and is likely to be less than predicted. These slope factors also are accompanied by a weight-of-evidence classification which designates the strength of the evidence that a particular chemical is a potential human carcinogen. Table 4-1 presents the USEPA weight of evidence classifications.

RfD and CSF values are available from the USEPA's Integrated Risk Information System (IRIS) database (USEPA, 1993a) which is updated monthly. For RfDs, the USEPA has formed an RfD Work Group to review existing data used to derive these values. Once this review has been completed, the verified RfD appears in IRIS. The USEPA also has formed the Carcinogen Risk Assessment Verification Endeavor (CRAVE) Work Group to review and validate toxicity values used in developing CSFs. Once the slope factors have been verified via extensive peer review, they also appear in the IRIS database. RfD and CSF values also are published in the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1993b). HEAST provides interim (unverified) RfDs and CSFs, is updated annually with occasional supplemental updates, and is published by the USEPA.

An RfD value currently is not available for PCBs. An oral CSF value of 7.7 $(mg/kg\text{-}day)^{-1}$ has been published in IRIS and is the toxicity value used in this evaluation.

TABLE 4-1

USEPA WEIGHT-OF-EVIDENCE CATEGORIES FOR POTENTIAL CARCINOGENS

USEPA Category	Description of Group	Description of Evidence
Group A	Human carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer.
Group B1	Probable human carcinogen	Limited evidence of carcinogenicity in humans from epidemiologic studies.
Group B2	Probable human carcinogen	Sufficient evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans.
Group C	Possible human carcinogen	Limited evidence of carcinogenicity in animals.
Group D	Not classified	Inadequate evidence of carcinogenicity in animals.
Group E	No evidence of carcinogenicity in humans	No evidence for carcinogenicity in at least two adequate animal tests or in both epidemiologic and animal studies.

Source: Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). USEPA, 1989.

5.0 EXPOSURE ASSESSMENT

The exposure assessment identifies pathways and routes by which site related constituents may reach potential receptors. An exposure pathway consists of four essential elements:

- A source
- A transport medium
- An exposure point
- An exposure route

When all four of these components are present, the exposure pathway is considered complete. Complete exposure pathways, coupled with specific toxicological information, allow for the assessment of potential human health risk.

5.1 Exposure Pathways

The exposure pathway of primary concern in this risk evaluation is incidental soil ingestion. The potential ingestion of soil may occur by incidental oral contact with hands, arms, or food items to which soil particles have adhered. Because of the limited size of Site 5, the potential for air emissions of contaminated soil particulates is not believed to be a significant exposure pathway. For this reason, inhalation of contaminated particulates was not retained as a potential human exposure pathway. In addition, due to the nature of this assessment, dermal contact with soil has not been quantitatively evaluated (see Section 7.2).

5.2 Potential Receptors

Currently, there is no activity at the site; therefore, the potential receptors evaluated in this risk evaluation include:

- Future Station personnel
- Future construction workers
- Future residents

Future Station personnel and future construction workers were selected because these receptors may contact PCBs in surface soil during the course of renovation or demolition activities at Site 5. In the event of

future residential property development, children and adults were selected because they may contact PCBs in surface soil while playing in the area and performing outdoor activities (e.g., lawn maintenance). Although Site 5 currently is unoccupied and surrounded by a fence, these receptors have been evaluated to assess the future potential "worst case" exposure scenarios.

5.3 Quantification of Exposure

USEPA Region III Risk-Based Concentration (RBC) levels were used to assess risk (USEPA, 1993c). Therefore, exposure has been quantified in conjunction with toxicity and is presented in the risk characterization section (Section 6.0). Because the RBC values do not incorporate dermal contact or inhalation, these pathways have not been assessed in this section. However, they will be assessed quantitatively in Section 7.2 of the uncertainty analysis. The following exposure assumptions were used in calculating the RBC values as presented in the Region III Risk-Based Concentration Table, Second Quarter 1994 (see Appendix B). It should be noted that the USEPA RBC tables are updated quarterly. Assumptions for the noncarcinogenic compound evaluation have not been included since PCBs have been evaluated as carcinogens only.

5.3.1 Commercial/Industrial Soil Exposure (Future Station Personnel and Construction Workers)

The following assumptions were used in the development of RBC values for future commercial/industrial property use for adult occupational exposure and include:

Ingestion rate	=	100 milligrams per day (mg/day)
Body weight	=	70 kilograms (kg)
Exposure frequency	=	250 days/year
Exposure duration	=	25 years
Averaging time (carcinogens)	=	25,550 days

In 1991, the USEPA published the "Standard Default Exposure Factors" that addresses commercial/industrial soil exposure factors to be used in the Remedial Investigation/Feasibility Study (RI/FS) process. These estimates assume an exposure duration of one year (an anticipated length of construction) with a default exposure frequency of 100 days/year and an ingestion rate (for construction workers engaging in excavation activities) of 480 mg/day. However, the USEPA Region III RBC values use a lower ingestion rate of 100 mg/day but a more conservative exposure frequency of 250 days/year and exposure duration of 25 years. The USEPA Region III RBC exposure values were used in this risk evaluation.

5.3.2 Residential Soil Exposure (Future Residents)

The following assumptions were used in the development of RBC values derived for future residential property use and include:

Ingestion factor, age adjusted	=	114.29 mg-yr/kg-day
Exposure frequency	=	350 days/year
Exposure duration	=	30 years
Averaging time (carcinogens)	=	25,550 days

These exposure factors correspond to USEPA promulgated default exposure factors for residential property use with the exception of the ingestion rate which has been age adjusted to represent both child and adult exposure.

6.0 RISK CHARACTERIZATION

The risk characterization for Site 5 has been conducted using an alternate method to the traditional methodology used in a baseline risk assessment due to the site's small size and the limited number of COPCs. In this characterization, USEPA Region III RBC values, protective of the 10^{-6} incremental cancer risk (ICR) level for both future commercial/industrial and future residential soil exposure, were evaluated. The exposure assumptions used to generate these RBC values are summarized in Section 5.3. The equations used to calculate these RBCs and the comprehensive list of RBC values are presented in Appendix B, Risk-Based Concentration Table, Second Quarter 1994.

ICR values were obtained by dividing the maximum detected soil concentration (1.4 mg/kg PCBs) by the RBC value, either commercial/industrial or residential, then multiplying this ratio by 10^{-6} to present the potential carcinogenic risk posed by exposure to this concentration of PCBs. The maximum detected value ($COPC_{max}$) was chosen to evaluate a worst case exposure at Site 5. Table 6-1 presents the results of these calculations.

From this analysis, ICRs for future commercial/industrial and future residential property use are 4×10^{-6} and 2×10^{-5}, respectively. These values fall within USEPA's target risk range of 10^{-6} to 10^{-4}.

TABLE 6-1

ICR VALUE CALCULATIONS
NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINA

COMMERCIAL/INDUSTRIAL SOIL (mg/kg):

$$\frac{1.4\ mg/kg}{0.37\ mg/kg} \times 10^{-6} = 3.78 \times 10^{-6} \approx 4 \times 10^{-6}$$

RESIDENTIAL SOIL (mg/kg):

$$\frac{1.4\ mg/kg}{0.083\ mg/kg} \times 10^{-6} = 1.68 \times 10^{-5} \approx 2 \times 10^{-5}$$

Notes:

- 1.4 mg/kg represents the highest PCB concentration detected in soils
- 0.37 mg/kg is the RBC value for commercial/industrial soil
- 0.083 mg/kg is the RBC value (combining adult and child) for residential soil
- 10^{-6} is a multiplier to convert the fraction to an ICR value

ICR = Incremental Cancer Risk

Source: USEPA, Region III Risk-Based Concentration Table. Second Quarter, 1994.

7.0 UNCERTAINTY ANALYSIS

Uncertainties are encountered throughout the risk evaluation process and include uncertainties present in the analytical data, the exposure assessment, and the toxicity assessment. Table 7-1 presents a qualitative evaluation of uncertainties and their effects on the estimation of human health risks.

7.1 Uncertainties in Analytical Data

Analytical data are limited by the precision and accuracy of the methods of analysis. Analytical data are not absolute numbers and variability in sample results is inherent. The amount of variability in analytical results depends upon the sample media and the presence of interfering compounds. In addition, the number of sampling points also can directly affect the reliability of a risk evaluation. However, the potential effects on the overestimation or underestimation of risks are considered to be low.

7.2 Uncertainties in Exposure

In performing exposure assessments, uncertainties arise from two main sources. First, uncertainties are inherent in estimating future potential human activity patterns at the site(s). Second, uncertainties arise in the estimation of chemical intakes resulting from contact by a receptor with a particular medium.

Current activity patterns at Site 5 are limited because the site is fenced and because of the relatively small area of the cement pads. Building 76 currently is not in use, therefore, the need to access the area also is limited. The most conservative activity pattern from a human health perspective is the consideration of future potential residential development of the property. This future property use, though highly unlikely, was evaluated in the risk evaluation to prevent the underestimation of future human health effects at Site 5.

USEPA Region III RBC values use conservative USEPA promulgated default exposure factors and consider potential ingestion of soil. Dermal contact is not considered because the dermal exposure route accounts for a small percentage of the overall daily intake relative to ingestion. This may not, however, be the case when considering construction workers as likely receptors to soil borne contaminants.

To determine whether the risk screening approach is adequately protective, risks for future construction workers and future residents were derived according to RAGs, using default exposure factors. ICR values derived using maximum detected Aroclor-1260 concentrations, considering both dermal contact and accidental ingestion, were 5.8×10^{-6} and 9.7×10^{-6}, respectively. Dermal contact was responsible for

TABLE 7-1

SUMMARY OF UNCERTAINTIES IN THE RESULTS OF THE SITE 5 RISK SCREENING NAVAL WEAPONS STATION YORKTOWN YORKTOWN, VIRGINIA

Uncertainty	Potential Magnitude for Over-Estimation of Risks	Potential Magnitude for Under-Estimation of Risks	Magnitude for Over or Under-Estimation of Risk
Analytical Data			
Sufficient samples may not have been taken to characterize the media being evaluated.			Low
Systematic or random errors in the chemical analysis may yield erroneous data.			Low
Exposure Assessment			
The use of the maximum detected Aroclor-1260 concentration in the estimation of the ICR.	Low		
The use of default USEPA Region III RBC exposure values in the calculation of potential exposure at Site 5.			Low
Toxicological Assessment			
Toxicological indices derived from high dose animal studies, extrapolated to low dose human exposure.	Moderate		
Risk Characterization			
Comparison of site data to USEPA Region III RBCs to determine potential human health risk estimates.			Low

Notes: Low - Assumptions categorized as "low" may effect risk estimates by less than one order of magnitude.

Moderate - Assumptions categorized as "moderate" may effect estimates of risk by between one and two orders of magnitude.

High - Assumptions categorized as "high" may effect estimates of risk by more than two orders of magnitude.

Source: Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). USEPA, 1989.

approximately 35 percent of both ICR values. Calculations of risks for both future construction workers and future residents are presented in Appendix C. These calculations confirm that the use of the risk screening approach is adequately conservative despite the fact that the dermal exposure pathway is not included, and will not underestimate potential human health risks at Site 5. The conservatism in the risk screening approach stems from the use of age adjusted intake rates. Using age adjusted intake rates in the risk screening compensates for not evaluating the dermal exposure pathway and produces risk estimates similar to those which would be derived in the standard baseline risk assessment process.

USEPA's Second Quarter 1994 RBCs were derived using age adjusted factors which combine ingestion rates, body weights and exposure duration. The factor is averaged over a 30-year period, however, the use of a 70-year time period would better represent potential carcinogens because CSFs are derived by averaging over a 70-year lifetime. Second Quarter 1994 RBCs are more conservative than previous RBCs by 50 percent. Despite the fact that the most recent second quarter values may not account for the entire exposure duration, these values will be used in the risk evaluation for the sake of conservatism.

Conservative default exposure factors represent upper confidence interval values for the ingestion rate, exposure frequency, and duration and are intended to err conservatively and not underestimate potential exposure. Therefore, given the size of Site 5 and the RBCs and corresponding ICR values, it is highly probable that the potential for human health effects for future commercial/industrial and future residential property use have been overestimated (i.e., actual risks are likely to be lower than those calculated, particularly in light of the fact that the maximum detected concentration was used to calculate the risk).

7.3 Uncertainties in Toxicity

In making quantitative estimates of the toxicity of varying dosages of compounds to human receptors, uncertainties arise from two sources. First, data on human exposure and the subsequent effects are usually insufficient, if they are at all available. Human exposure data usually lack adequate concentration estimations and suffer from inherent temporal variability. Therefore, animal studies are often used and new uncertainties arise from the process of extrapolating animal results to humans. Second, to obtain observable effects with a manageable number of experimental subjects, high doses of a compound are often used. In this situation, a high dose means that high exposures are used in the experiment with respect to most environmental exposures. Therefore, when applying the results of the animal experiment to the human condition, the effects at high doses must be extrapolated to approximate effects at lower doses.

In extrapolating effects from high doses in animals to low doses in people, scientific judgment and conservative assumptions are employed. In selecting animal studies for use in dose-response calculations, the following factors are considered:

- Studies are preferred where the animal closely mimics human pharmacokinetics.
- Studies are preferred where dose intake most closely mimics the intake route and duration for humans.
- Studies are preferred which demonstrate the most sensitive response to the compound in question.

For compounds believed to cause threshold effects (i.e., noncarcinogens), safety factors are employed in the extrapolation of effects from animals to humans and from high doses to low doses.

The use of conservative assumptions results in quantitative indices of toxicity that are not expected to underestimate potential toxic effects; however, this may overestimate these effects by an order of magnitude or more.

8.0 SUMMARY AND CONCLUSIONS

Site 5 was used from 1940 to 1981 as a storage area for PCB-containing transformers; an estimated 300 pounds of PCB-containing fluids were reported to have leaked over this time period. In December 1982, contaminated soils were removed from the area; however, the results of this removal effort were not verified. As such, sampling was conducted in 1992 to confirm the soil removal. This report has presented and summarized the analytical data and evaluated the potential risk posed by exposure to the PCBs currently detected in the soil at Site 5.

Future Station personnel, future construction workers, and future residents were considered to be the populations most at risk. It was assumed that each of these populations could potentially contact PCB-contaminated soils by soil ingestion. Based on the USEPA Region III commercial/industrial soil RBC, a risk value of 4×10^{-6} was estimated for potential exposure to PCBs by future Station personnel and future construction workers. Based on the residential soil RBC, a risk value of 2×10^{-5} was calculated for potential exposure to PCBs by future residents (both adults and children). Each of these risk values fall within the USEPA's target risk range of 1×10^{-4} to 1×10^{-6} utilizing conservative exposure assumptions, and the maximum detected concentration in soil (1.4 mg/kg). As such, no further remedial action is recommended for Site 5. A no-action Proposed Remedial Action Plan and Record of Decision should be prepared.

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APPENDIX A
TOXICOLOGICAL PROFILE FOR POLYCHLORINATED BIPHENYLS

Date of Last Revision: 6/18/93

Revisor: Rich Hoff

POLYCHLORINATED BIPHENYLS (PCBS)

INTRODUCTION

Chemical Name: Polychlorinated Biphenyls (PCBs)

Synonyms and Trade Names: Aroclor, Kanechlor, Clophen

CAS Numbers: Aroclor 1242: 53469-21-9
Aroclor 1248: 12672-29-6
Aroclor 1254: 11097-69-1
Aroclor 1260: 001336-36-3

Molecular Formula: $C_6H_xCl_xC_6H_xClx$

Molecular Weights: Aroclor 1242: 266.5 g/mole
Aroclor 1248: 299.5 g/mole
Aroclor 1254: 328.4 g/mole
Aroclor 1260: 377.8 g/mole

The term polychlorinated biphenyls (PCBs) commonly refers to a variety of mixtures of individual biphenyl isomers, each consisting of two joined benzene rings and up to ten chlorine atoms. Mixtures of these isomers are known by their commercial designation of Aroclor. This trade name is followed by a four-digit number; the first two numbers indicate the type of isomer mixture and the last two numbers indicate the approximate weight percent of chlorine in the mixture (3).

PCBs are man-made chemicals that were used widely in transformers, electrical equipment and as lubricants (2). Because of their persistence and toxicity in the environment, their manufacture was discontinued in the United States in 1977 (1). However, PCB equipment manufactured before 1977 is currently still being used in the U.S. and this use is being regulated by the Environmental Protection Agency.

PCBs are very stable chemically and tend to be persistent in the environment. Persistence and bioaccumulation in living organisms also occur due to the high lipophilicity of these compounds (2).

CHEMICAL AND PHYSICAL PROPERTIES

Aroclor	1242	1248	1254	1260
Log K_{oc}	3.8	5.75	5.51	6.3
Log K_{ow}(2):	5.6	6.11	6.03	7.15
Henry's Law Constant(2): (atm-m^3/mol at 25° C)	$5.7x10^{-4}$	$3.5x10^{-3}$	$8.4x10^{-3}$	$7.1x10^{-3}$
Water Solubility (mg/L):	0.24	0.054	0.012	0.0027
Vapor Pressure(2): (mm Hg at 25° C)	$4.06x10^{-4}$	$4.94x10^{-4}$	$7.71x10^{-5}$	$4.0x10^{-5}$
Density (2):	1.35	1.41	1.50	1.57

FATE AND TRANSPORT

PCBs can be found in the atmosphere, water, and soil. Adsorption to sediments is the major fate process for PCBs in water. Because of lower water solubilities and higher octanol-water partition coefficients, higher chlorinated isomers will adsorb more strongly than the lower chlorinated isomers. This also indicates that significant leaching should not occur in soil under most conditions (2).

For PCBs that exist in the dissolved state in water, volatilization becomes the primary fate process. Therefore, the volatilization process is the major removal mechanism of PCBs from water sources. However, the rate of volatilization is dependent upon PCB adsorption to sediment (2).

In the atmosphere, PCBs exist in the vapor phase and can be removed by wet and dry deposition. A typical range of PCB concentrations in the atmosphere is between 1 and 250 µg/L (2).

Degradation of PCBs in the environment is dependent upon the degree of chlorination. Generally, the more chlorinated the PCB molecule, the more persistent it will be in the environment. Factors which determine biodegradability include the amount of chlorination, concentration, type of microbial population, available nutrients, and temperature (2). The

dominant degradation process in the atmosphere is dependent upon the vapor phase reaction of PCBs with hydroxyl radicals (2).

Photolysis is thought to be the only transformation process in the aquatic environment. However, the process is extremely slow. It appears the hydrolysis and oxidation do not degrade PCBs (2).

In the atmosphere, typical airborne concentrations of PCBs are as follows (2):

Location	Concentration Range (mg/m^3)
Urban	0.5 to 30
Rural	0.1 to 2.0
Great Lakes	0.4 to 3.0
Marine	0.05 to 2.0
Remote	0.02 to 0.5

The concentrations of PCBs in the open waters of oceans and lakes are shown below (2):

Location	Concentration Range (µg/L)
North Pacific	0.04 to 0.59
Antarctic	0.035 to 0.069
North Atlantic	0.02 to 0.20
Lake Superior	0.63 to 3.30
Lake Michigan	3.0 to 9.0
Lake Huron	0.49 to 17.15

PCBs are found in the soils from different areas of the world in the following concentrations (2):

Location	Concentration Range (ppb)
Great Britain	2.3 to 444
South Wales/Scotland	4.5 to 47.7
Japan	<10 to 100
United States	
Everglades National Forest, Florida	<1 to 33
U.S. Urban areas	0.02 to 11.94
Rocky Mountain National Park	0.098 to 0.54
Great Lakes	2.5 to 251.7

PHARMACOKINETICS

PCBs are absorbed primarily through inhalation and dermal contact in occupational environments. However, the general public absorbs PCBs primarily through oral exposure, such as the ingestion of PCB contaminated fish (2).

Animal studies have shown that PCBs are readily absorbed, but studies to quantify the rate of absorption are needed. Studies indicate that PCBs are absorbed by the gastrointestinal tract, and have been found in the serum and breast milk of woman orally exposed to PCBs (2).

PCBs accumulate in human plasma and adipose tissue with the extent of accumulation dependent on the positions of chlorines on the PCB congeners. Congeners with chlorines in both 4 positions as opposed to the 3 ,4 positions were found in greater concentrations (2). Also, PCBs have been shown to accumulate in human breast milk. The extent of accumulation is approximately 4 to 10 times less than the concentration in maternal blood (2).

Animal studies have indicated maximum concentrations in the liver, brain, and adipose tissue. Studies show that distribution occurs in a biphasic manner. First, PCBs accumulate in the liver and muscle from the blood stream. Following this accumulation, PCBs are either

stored in the adipose tissue or metabolized by the liver. It has been suggested that PCBs concentrate in the adipose tissue regardless of the route of exposure (2).

The metabolism of PCBs depends on chlorine content and on the site of chlorination. The major metabolic products are phenolic in nature. Other identified end products are sulfur-containing compounds, trans-dehydrodiols, polyhydroxylated PCBs and methyl ether derivatives (2).

Data regarding the excretion of PCBs following inhalation or dermal exposure are not available. When oral exposure occurs, excretion is dependent upon the metabolism of PCBs to more polar compounds (2).

HUMAN HEALTH EFFECTS

Noncarcinogenic Effects

The evaluation of the toxicity of PCBs is complicated by a number of factors including differences in isomer/congener/mixture composition, differences in species susceptibility, quantitatively inconsistent data, and varying degrees of contamination from other chemicals such as chlorinated dibenzofurans. Also, it should be noted that because of changes in congener and impurity composition resulting from environmental and/or biological transformations, PCBs currently in the environment may differ from the original PCB mixture (2).

Inhalation Exposure

There are no human data available regarding the lethality/decreased longevity of humans due to acute or chronic inhalation exposure. However, the primary target organs associated with PCB inhalation are the liver and cutaneous tissue. Occupational exposure has been associated with elevated serum levels in the liver and enzyme and dermatologic effects such as chloracne and skin rashes (2).

Human developmental studies have proved inconclusive and lack monitoring data. However, there were suggestions that mothers occupationally exposed to PCBs exhibited a slight decrease in birth weight and gestational age of offspring. No animal studies were available concerning developmental toxicity (2).

In animals, the liver and skin are unequivocal targets of PCB toxicity, especially in terms of chronic toxicity. The range of toxicity for dermal and hepatic effects is from 0.007 to 11.0 mg/m^3 (2).

Oral Exposure

There are no studies which address oral PCB exposure in humans. However, animal studies have established a single dose LD50s for rats and mice. The levels are 1,010 mg/kg for Aroclor 1254 and 750 mg/kg for Aroclor 1221, respectively (2).

Systemic effects in animals include perturbations of the liver and cutaneous tissues. Rats fed 0, 4, 8, and 16 ppm of Aroclor 1254 for 4 days resulted in an increase in liver weight at concentrations greater than 8 ppm and an increase of serum HDL cholesterol levels at 16 ppm. A lowest observed adverse effect level (LOAEL) of 5 ppm was identified in rats based on hepatic effects. At this level, hepatic microsomal enzyme activities increased, production of liver lipid content increased, and frank degenerative liver alterations were observed (2).

Developmental effects in humans from oral exposure to PCB contaminated fish include effects on birth weight, head circumference, gestational age and/or neonatal behavior. For animals, a LOAEL of 50 ppm in female rats has been identified based on fetotoxicity. At this level, effects such as reduced litter size, ultrastructural lesions in the thyroid follicular cells of neonates and weanlings and reduced serum levels of thyroid hormone were observed (2).

The only study relating PCBs to reproduction demonstrated that doses of >2 ppm Aroclor 1254 administered to mink for 4 months prior to mating and during gestation were lethal to fetuses and caused reproductive failure (2).

Dermal Exposure

Dermal exposure is a major route of PCB absorption. However, the current data does not allow for the quantification of dermal absorption to the total body burden of PCBs (2).

A study involving capacitor workers does not show clear evidence of liver disease. However, a correlation can be made between the PCB exposure and liver enzyme induction in the workers.

It is not clear to what extent the dermal absorption affected the hepatic changes since inhalation exposure also occurred (2).

A study involving dermal exposure of Aroclor 1260 to a female New Zealand rabbits for 5 days/week at a dose of 118 mg/day for 38 days produced degenerative lesions of the liver and kidneys, increased fetal porphyrin elimination and hyperplasia and hyperkeratosis of the follicular and epidermal epithelium (2). Other studies indicate that the median lethal dose for single dermal exposure for rabbits was >1269 mg/kg for Aroclor 1242 and 1248 to <3,169 for Aroclor 1221 (2).

No studies have been located which address immunological, neurological, developmental or reproductive effects of PCBs on humans or animals (2).

Carcinogenic Effects

The EPA has classified PCBs as a Group B2 carcinogen - a probable human carcinogen. This classification is based on the evidence of hepatocellular carcinomas in three strains of rats and two strains of mice. There is suggestive evidence that links PCBs to liver cancer in humans by the ingestion, inhalation, or dermal pathways. However, this evidence is inadequate due to confounding factors and lack of exposure quantification (4).

There have been several studies attempting to associate PCB exposure with carcinogenicity. In New Jersey, a petrochemical plant reported a statistically significant increase in malignant melanomas among 31 research and development employees and 41 refinery workers. Because the study failed to report quantified exposure levels and to identify the presence of other potential or known carcinogens, it was discredited (4).

Two outbreaks of poisoning following accidental consumption of PCB-contaminated rice oil (also containing polychlorinated dibenzofurans and polychlorinated quinones) occurred in Japan in 1968 (Yusho) and in Taiwan in 1979 (Yu-Cheng). A 16-year mortality study was completed which identified an increase in liver cancer in both males and females. There is strong evidence indicating the health effects were attributable to the polychlorinated dibenzofurans in the oil as opposed to the PCBs. Therefore, this study only suggests carcinogenicity of PCBs (4).

ENVIRONMENTAL HEALTH EFFECTS

Aquatic

PCBs have the capability to bioaccumulate and biomagnify. For rainbow trout, bluegills and channel catfish, the 96-hour LC50 values were around 20 mg/liter. When the exposure was increased to 10 to 20 days, the average LC50 value was 0.1 mg/liter. Studies indicate that juvenile organisms appear to be more susceptible to PCBs than either eggs or adults (3).

A study which experimentally determined the bioconcentration factors of various Aroclors in aquatic species found bioconcentration factors ranging from 26,000 to 660,000 (2).

In a study conducted by the U.S. Fish and Wildlife Service, 315 fish from 107 stations nationwide were analyzed for PCBs. Results showed that 94% of all fish were found to contain PCB residues. The geometric mean concentration of all Aroclors was found to be 0.53 µg/g. It should be noted that this study included the analyses of whole fish samples which include both the edible and nonedible portions of the fish. Therefore, the concentration will not reflect the actual human exposure through oral consumption (2).

Subsequent studies have shown PCB levels in fish collected and analyzed from Lake Huron to contain 600 to 72,000 µg/g PCBs on a lipid basis. Analyses of 62 samples of commercial fish collected from Lake Ontario revealed PCB levels ranging from 0.11 to 4.90 ppm (2).

The Ambient Water Quality Criteria for the protection of aquatic organisms are as follows (3):

Freshwater:

Acute toxicity: 2.0 µg/L

Chronic toxicity: 0.014 µg/L

Marine:

Acute toxicity: 10.0 µg/L

Chronic toxicity: 0.030 µg/L

Terrestrial and Avian

PCBs can affect terrestrial wildlife in three primary ways: mortality, adversely affecting reproduction, and changing behavior. Behavior effects include increased activity, decreased avoidance response, and decreased nesting (3).

In sensitive bird species, PCB levels of greater than 200 ppm in the diet or 10 mg/kg body weight caused some mortality. When the doses were increased to 1,500 ppm or 100 mg/kg body weight, extensive mortality was exhibited (3).

In studies in which chicken were fed levels of 20 ppm PCBs in the diet, lower egg production, deformities, decreased hatchability, lower growth, and survival were observed (3).

REGULATORY LEVELS AND CRITERIA

OSHA Advisory TWA (2): Aroclor 1242 - 1.0 mg/m3
Aroclor 1254 - 0.5 mg/m3

FDA Temporary Tolerances (2): Foods - 0.2-3.0 ppm
Packaging - 10.0 ppm

NIOSH: REL-TWA (2): 1.0 µg/m3

ACGIH (2):

TLV-TWA for Aroclor 1242: 1.0 mg/m3

TLV-TWA for Aroclor 1254: 0.5 mg/m3

Ambient Water Quality Criteria (2): 0.79 to 0.0079 ng/L for carcinogenicity at 10-5 to 10-7 risk levels

Drinking Water Criteria (2): 0.5 to 0.005 µg/L for carcinogenicity at 10-4 to 10-6 risk levels

Reportable Quantity (2): 10 lbs. (statutory)
1 lb. (proposed)

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification (4) Group: B2-Probable human carcinogen

Noncarcinogenic Effects:

Oral RfD (4):	Not Available
Inhalation RfC (4):	Not Available

Carcinogenic Effects:

Oral CSF(4):	7.7 $(mg/kg/day)^{-1}$
Inhalation CSF (4):	Not Available.

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APPENDIX B
USEPA REGION III RISK-BASED CONCENTRATION TABLE
SECOND QUARTER 1994

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region III
841 Chestnut Street
Philadelphia, Pennsylvania 19107

April 20, 1994

SUBJECT: Risk-Based Concentration Table, Second Quarter 1994

FROM: Roy L. Smith, Ph.D., Senior Toxicologist
Technical Support Section (3HW13)

TO: RBC Table mailing list

Attached is the EPA Region III risk-based concentration table, which we have distributed quarterly to all interested parties since 1991. If you are not currently on the mailing list, but would like to be, please contact Anna Poulton (phone: 215-597-3179, fax: 215-597-9890) and give her your name, address, and phone and fax numbers.

The table contains reference doses and carcinogenic potency slopes (obtained from IRIS through April 1, 1994, HEAST through November 1993, OHEA-Cincinnati, and other EPA sources) for nearly 600 chemicals. These toxicity constants have been combined with "standard" exposure scenarios to calculate chemical concentrations corresponding to fixed levels of risk (*i.e.*, a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration) in water, air, fish tissue, and soil.

The Region III toxicologists use this table as a risk-based screen for Superfund sites, and as a desk reference for emergencies and requests for immediate information. The table also provides a useful benchmark for evaluating site investigation data and preliminary remediation goals. The table has no official status as either regulation or guidance, and should be used only as a predictor of generic single-contaminant health risk estimates. *The table is specifically not intended as (1) a stand-alone decision-making tool, (2) a substitute for EPA guidance for preparing baseline risk assessments, (3) a source of site-specific cleanup levels, or (4) a rule to determine if a waste is hazardous under RCRA.* In general, chemical concentrations above the levels in the table suggest a need for a closer look by a toxicologist, but should not be used as the sole basis for taking any action.

The toxicity information in the table has been assembled by hand, and (despite extensive checking and years of use) may contain errors. It's advisable to cross-check before relying on any numbers in the table. If you find any errors, please send me a note.

This issue of the table includes a revised legend at the top of each page, in which a 'w' flag (meaning that the value has been withdrawn from either IRIS or HEAST) has been substituted for the former 'x' and 'y' flags. The flag change had already been made in the previous version of the table, but I forgot to change the legend. Several people noticed, and asked about it. Also, all newly revised reference doses and potency slopes now appear underlined and in boldface for quick recognition. The shading used in the previous version copied poorly.

I get telephone calls from many of you about the table, but I'm often unavailable to answer the phone. Since you have the same problem, we play a lot of "phone tag". To increase my responsiveness to your technical questions and concerns, I suggest that you fax them to me at 215-597-9890. I'll respond by return fax as soon as possible. The turnaround will probably be quicker, and the response may also be more thoughtful.

Attachment

Risk-Based Concentration Table
Background Information

General: Separate carcinogenic and non-carcinogenic risk-based concentrations were calculated for each compound for each pathway. The concentration in the table is the lower of the two, rounded to two significant figures. The following terms and values were used in the calculations:

Exposure variables	Value	Name
1-General:		
Carcinogenic potency slope oral (risk per mg/kg/d):	*	CPSo
Carcinogenic potency slope inhaled (risk per mg/kg/d):	*	CPSi
Reference dose oral (mg/kg/d):	*	RfDo
Reference dose inhaled (mg/kg/d):	*	RfDi
Target cancer risk:	1e-06	TR
Target hazard quotient:	1	THQ
Body weight, adult (kg):	70	BWa
Body weight, age 1-6 (kg):	15	BWc
Averaging time carcinogens (d):	25550	ATc
Averaging time non-carcinogens (d):	ED*365	ATn
Inhalation, adult (m3/d):	20	IRAa
Inhalation, child (m3/d):	12	IRAc
Inhalation factor, age-adjusted (m3-y/kg-d):	11.66	IFAadj
Tap water ingestion, adult (L/d):	2	IRWa
Tap water ingestion, age 1-6 (L/d):	1	IRWc
Tap water ingestion factor, age-adjusted (L-y/kg-d):	1.09	IFWadj
Fish ingestion (g/d):	54	IRF
Soil ingestion, adult (mg/d):	100	IRSa
Soil ingestion, age 1-6 (mg/d):	200	IRSc
Soil ingestion factor, age adjusted (mg-y/kg-d):	114.29	IFSadj
2-Residential:		
Exposure frequency (d/y):	350	EFr
Exposure duration, total (y):	30	EDtot

Exposure variables	Value	Name
Exposure duration, age 1-6 (y):	6	EDc
Volatilization factor (L/m3):	0.5	VF
3-Occupational:		
Exposure frequency (d/y):	250	EFo
Exposure duration (y):	25	EDo
* = Contaminant-specific toxicity parameters		

The priority among sources of toxicological constants was as follows: (1) IRIS, (2) HEAST, (3) HEAST alternative method, (4) ECAO-Cincinnati, (5) withdrawn from IRIS, (6) withdrawn from HEAST, and (7) other EPA documents. Each source was used only if numbers from higher-priority sources were unavailable.

Algorithms:

1. Age-adjusted factors: Because contact rates with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age-adjusted factors. These factors approximated the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults. The age-adjusted factor for soil was obtained from RAGS IB; the others were developed by analogy.

a. Air inhalation ([m^3· y]/[kg· d]):

$$IFAadj = \frac{EDc \cdot IRAc}{BWc} + \frac{(EDtot - EDc) \cdot IRAa}{BWa}$$

b. Tap water ingestion ([L· y]/[kg· d]):

$$IFWadj = \frac{EDc \cdot IRWc}{BWc} + \frac{(EDtot - EDc) \cdot IRWa}{BWa}$$

c. Soil ingestion ([mg· y]/[kg· d]):

$$IFSadj = \frac{EDc \cdot IRSc}{BWc} + \frac{(EDtot - EDc) \cdot IRSa}{BWa}$$

2. Residential water use ($\mu g/L$). Volatilization terms were calculated only for compounds with "***" in the "VOC" column. Compounds having a Henry's Law constant greater than 10^{-5} were considered volatile. The list may be incomplete, but is unlikely to include false positives. The equations and the volatilization factor (VF, above) were obtained from RAGS IB. Oral potency slopes and reference doses were used for both oral and inhaled exposures for volatile compounds lacking inhalation values. Inhaled potency slopes were substituted for unavailable oral potency slopes only for volatile compounds; inhaled RfDs were substituted for unavailable oral RfDs for both volatile and non-volatile compounds.

a. Carcinogens: Calculations were based on combined childhood and adult exposure.

$$\frac{TR \cdot ATc \cdot 1000\frac{ug}{mg}}{EFr \cdot ([VF \cdot IFAadj \cdot CPSi] + [IFWadj \cdot CPSo])}$$

b. Non-carcinogens: Calculations were based on adult exposure.

$$\frac{THQ \cdot BWa \cdot ATn \cdot 1000\frac{ug}{mg}}{EFr \cdot EDtot \cdot \left(\frac{VF \cdot IRAa}{RfDi} + \frac{IRWa}{RfDo}\right)}$$

3. Air ($\mu g/m^3$). Oral potency slopes and references were used where inhalation values were not available.

a. Carcinogens: Calculations were based on combined childhood and adult exposure.

$$\frac{TR \cdot ATc \cdot 1000\frac{ug}{mg}}{EFr \cdot IFAadj \cdot CPSi}$$

b. Non-carcinogens: Calculations were based on adult exposure.

$$\frac{THQ \cdot RfDi \cdot BWa \cdot ATn \cdot 1000\frac{ug}{mg}}{EFr \cdot EDtot \cdot IRAa}$$

4. Fish (mg/kg):

a. Carcinogens: Calculations were based on adult exposure.

$$\frac{TR \cdot BWa \cdot ATc}{EFr \cdot EDtot \cdot \frac{IRF}{1000\frac{g}{kg}} \cdot CPSo}$$

b. Non-carcinogens: Calculations were based on adult exposure.

$$\frac{THQ \cdot RfDo \cdot BWa \cdot ATn}{EFr \cdot EDtot \cdot \frac{IRF}{1000\frac{g}{kg}}}$$

5. Soil commercial/industrial (mg/kg): The default exposure assumption that only 50% of incidental soil ingestion occurs at work has been omitted. Calculations were based on adult occupational exposure.

a. Carcinogens:

$$\frac{TR \cdot BWa \cdot ATc}{EFo \cdot EDo \cdot \frac{IRSa}{10^6\ \frac{mg}{kg}} \cdot CPSo}$$

b. Non-carcinogens:

$$\frac{THQ \cdot RfDo \cdot BWa \cdot ATn}{EFo \cdot EDo \cdot \frac{IRSa}{10^6\ \frac{mg}{kg}}}$$

6. Soil residential (mg/kg):

a. Carcinogens: Calculations were based on combined childhood and adult exposure.

$$\frac{TR \cdot ATc}{EFr \cdot \frac{IFSadj}{10^6\ \frac{mg}{kg}} \cdot CPSo}$$

b. Non-carcinogens: Calculations were based on childhood exposure only.

$$\frac{THQ \cdot RfDo \cdot BWc \cdot ATn}{EFr \cdot EDc \cdot \frac{IRSc}{10^6\ \frac{mg}{kg}}}$$

Sources: i=IRIS h=HEAST a=HEAST alt. w=Withdrawn from IRIS or HEAST e=EPA–ECAO o=Other EPA documents *Basis of RBC: c=carcinogenic effects n=noncarcinogenic effects.*

Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Acephate	30560191	4.00E–03 *i*		8.70E–03 *i*			7.7 *e*	0.72 *e*	0.36 *e*	330 *c*	73 *c*
Acetaldehyde	75070		2.57E–03 *i*		7.70E–03 *i*		94 *n*	0.81 *c*			
Acetochlor	34256821	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Acetone	67641	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Acetone cyanohydrin	75865	7.00E–02 *h*	2.86E–03 *a*				2600 *n*	10 *n*	95 *n*	72000 *n*	5500 *n*
Acetonitrile	75078	6.00E–03 *i*	1.43E–02 *a*				220 *n*	52 *n*	8.1 *n*	6100 *n*	470 *n*
Acetophenone	98862	1.00E–01 *i*	5.71E–06 *w*			***	0.042 *n*	0.021 *n*	140 *n*	100000 *n*	7800 *n*
Acifluorfen	62476599	1.30E–02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
Acrolein	107028	2.00E–02 *h*	5.71E–06 *i*				730 *n*	0.021 *n*	27 *n*	20000 *n*	1600 *n*
Acrylamide	79061	2.00E–04 *i*		4.50E+00 *i*	4.55E+00 *i*		0.015 *c*	0.0014 *c*	0.0007 *c*	0.64 *c*	0.14 *c*
Acrylic acid	79107	5.00E–01 *i*	1.00E–03 *i*				18000 *n*	3.7 *n*	680 *n*	510000 *n*	39000 *n*
Acrylonitrile	107131	1.00E–03 *h*	5.71E–04 *i*	5.40E–01 *i*	2.38E–01 *i*		0.12 *c*	0.026 *c*	0.0058 *c*	5.3 *c*	1.2 *c*
Alachlor	15972608	1.00E–02 *i*		8.00E–02 *h*			0.84 *c*	0.078 *c*	0.039 *c*	36 *c*	8 *c*
Alar	1596845	1.50E–01 *i*					5500 *n*	550 *n*	200 *n*	150000 *n*	12000 *n*
Aldicarb	116063	1.00E–03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
Aldicarb sulfone	1646884	1.00E–03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
Aldrin	309002	3.00E–05 *i*		1.70E+01 *i*	1.71E+01 *i*		0.004 *c*	0.00037 *c*	0.00019 *c*	0.17 *c*	0.038 *c*
Ally	74223646	2.50E–01 *i*					9100 *n*	910 *n*	340 *n*	260000 *n*	20000 *n*
Allyl alcohol	107186	5.00E–03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Allyl chloride	107051	5.00E–02 *w*	2.86E–04 *i*				1800 *n*	1 *n*	68 *n*	51000 *n*	3900 *n*
Aluminum	7429905	2.90E+00 *o*					110000 *n*	11000 *n*	3900 *n*	1000000 *n*	230000 *n*
Aluminum phosphide	20859738	4.00E–04 *i*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
Amdro	67485294	3.00E–04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Ametryn	834128	9.00E–03 *i*					330 *n*	33 *n*	12 *n*	9200 *n*	700 *n*
m–Aminophenol	591275	7.00E–02 *h*					2600 *n*	260 *n*	95 *n*	72000 *n*	5500 *n*
4–Aminopyridine	504245	2.00E–05 *h*					0.73 *n*	0.073 *n*	0.027 *n*	20 *n*	1.6 *n*
Amitraz	33089611	2.50E–03 *i*					91 *n*	9.1 *n*	3.4 *n*	2600 *n*	200 *n*
Ammonia	7664417		2.86E–02 *i*				1000 *n*	100 *n*			
Ammonium sulfamate	7773060	2.00E–01 *i*					7300 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
Aniline	62533		2.86E–04 *i*	5.70E–03 *i*			10 *n*	1 *n*	0.55 *c*	500 *c*	110 *c*
Antimony and compounds	7440360	4.00E–04 *i*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
Antimony pentoxide	1314609	5.00E–04 *h*					18 *n*	1.8 *n*	0.68 *n*	510 *n*	39 *n*
Antimony potassium tartrate	304610	9.00E–04 *h*					33 *n*	3.3 *n*	1.2 *n*	920 *n*	70 *n*
Antimony tetroxide	1332316	4.00E–04 *h*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
Antimony trioxide	1309644	4.00E–04 *h*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
Apollo	74115245	1.30E–02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
Aramite	140578	5.00E–02 *h*		2.50E–02 *i*	2.49E–02 *i*		2.7 *e*	0.25 *e*	0.13 *e*	110 *e*	26 *e*
Arsenic	7440382	3.00E–04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Arsenic (as carcinogen)	7440382			1.75E+00 *i*	1.51E+01 *i*		0.038 *o*	0.00041 *o*	0.0018 *o*	1.6 *o*	0.37 *o*
Arsine	7784421		1.43E–05 *i*				0.52 *n*	0.052 *n*			
Assure	76578148	9.00E–03 *i*					330 *n*	33 *n*	12 *n*	9200 *n*	700 *n*
Asulam	3337711	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*

Sources: i=IRIS h=HEAST a=HEAST alt. w=Withdrawn from IRIS or HEAST e=EPA–ECAO o=Other EPA documents *Basis of RBC: c=carcinogenic effects n=noncarcinogenic effects.*

Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Atrazine	1912249	3.50E–02 *i*		2.22E–01 *h*			0.3 *c*	0.028 *c*	0.014 *c*	13 *c*	2.9 *c*
Avermectin B1	65195553	4.00E–04 *i*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
Azobenzene	103333			1.10E–01 *i*	1.08E–01 *i*		0.61 *c*	0.058 *c*	0.029 *c*	26 *c*	5.8 *c*
Barium and compounds	7440393	7.00E–02 *i*	1.43E–04 *a*				2600 *n*	0.52 *n*	95 *n*	72000 *n*	5500 *n*
Baygon	114261	4.00E–03 *i*					150 *n*	15 *n*	5.4 *n*	4100 *n*	310 *n*
Bayleton	43121433	3.00E–02 *i*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
Baythroid	68359375	2.50E–02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
Benefin	1861401	3.00E–01 *i*					11000 *n*	1100 *n*	410 *n*	310000 *n*	23000 *n*
Benomyl	17804352	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Bentazon	25057890	2.50E–03 *i*					91 *n*	9.1 *n*	3.4 *n*	2600 *n*	200 *n*
Benzaldehyde	100527	1.00E–01 *i*				***	610 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Benzene	71432		1.43E–04 *o*	2.90E–02 *i*	2.90E–02 *i*	***	0.36 *c*	0.22 *c*	0.11 *c*	99 *c*	22 *c*
Benzenethiol	108985	1.00E–05 *h*					0.37 *n*	0.037 *n*	0.014 *n*	10 *n*	0.78 *n*
Benzidine	92875	3.00E–03 *i*		2.30E+02 *i*	2.35E+02 *i*		0.00029 *c*	0.000027 *c*	0.000014 *c*	0.012 *c*	0.0028 *c*
Benzoic acid	65850	4.00E+00 *i*					150000 *n*	15000 *n*	5400 *n*	1000000 *n*	310000 *n*
Benzotrichloride	98077			1.30E+01 *i*			0.0052 *c*	0.00048 *c*	0.00024 *c*	0.22 *c*	0.049 *c*
Benzyl alcohol	100516	3.00E–01 *h*					11000 *n*	1100 *n*	410 *n*	310000 *n*	23000 *n*
Benzyl chloride	100447			1.70E–01 *i*		***	0.062 *c*	0.037 *c*	0.019 *c*	17 *c*	3.8 *c*
Beryllium and compounds	7440417	5.00E–03 *i*		4.30E+00 *i*	8.40E+00 *i*		0.016 *c*	0.00075 *c*	0.00073 *c*	0.67 *c*	0.15 *c*
Bidrin	141662	1.00E–04 *i*					3.7 *n*	0.37 *n*	0.14 *n*	100 *n*	7.8 *n*
Biphenthrin (Talstar)	82657043	1.50E–02 *i*					550 *n*	55 *n*	20 *n*	15000 *n*	1200 *n*
1,1–Biphenyl	92524	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Bis(2–chloroisopropyl)ether	39638329	4.00E–02 *i*		7.00E–02 *h*	3.50E–02 *h*	***	0.26 *c*	0.18 *c*	0.045 *c*	41 *c*	9.1 *c*
Bis(chloromethyl)ether	542881			2.20E+02 *i*	2.17E+02 *i*	***	0.000049 *c*	0.000029 *c*	0.000014 *c*	0.013 *c*	0.0029 *c*
Bis(2–chloro–1–methylethyl)ether				7.00E–02 *w*	7.00E–02 *w*		0.96 *c*	0.089 *c*	0.045 *c*	41 *c*	9.1 *c*
Bis(2–ethylhexyl)phthalate (DEHP)	117817	2.00E–02 *i*		1.40E–02 *i*			4.8 *c*	0.45 *c*	0.23 *c*	200 *c*	46 *c*
Bis(chloroethyl)ether	111444			1.10E+00 *i*	1.16E+00 *i*	***	0.0092 *c*	0.0054 *c*	0.0029 *c*	2.6 *c*	0.58 *c*
Bisphenol A	80057	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Boron (and borates)	7440428	9.00E–02 *i*	5.71E–03 *h*				3300 *n*	21 *n*	120 *n*	92000 *n*	7000 *n*
Boron trifluoride	7637072		2.00E–04 *h*				7.3 *n*	0.73 *n*			
Bromodichloromethane	75274	2.00E–02 *i*		6.20E–02 *i*		***	0.17 *c*	0.1 *c*	0.051 *c*	46 *c*	10 *c*
Bromoethene	593602				1.10E–01 *h*	***	0.096 *c*	0.057 *c*			
Bromoform (tribromomethane)	75252	2.00E–02 *i*		7.90E–03 *i*	3.85E–03 *i*	***	2.4 *c*	1.6 *c*	0.4 *c*	360 *c*	81 *c*
Bromomethane	74839	1.40E–03 *i*	1.43E–03 *i*			***	8.7 *n*	5.2 *n*	1.9 *n*	1400 *n*	110 *n*
4–Bromophenyl phenyl ether	101553	5.80E–02 *o*					2100 *n*	210 *n*	78 *n*	59000 *n*	4500 *n*
Bromophos	2104963	5.00E–03 *h*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Bromoxynil	1689845	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Bromoxynil octanoate	1689992	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
1,3–Butadiene	106990				9.80E–01 *i*	***	0.011 *c*	0.0064 *c*			
1–Butanol	71363	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Butyl benzyl phthalate	85687	2.00E–01 *i*					7300 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
Butylate	2008415	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	510[illegible]	3900 *n*

Sources: I=IRIS h=HEAST a=HEAST alt. w=Withdrawn from IRIS or HEAST e=EPA–ECAO o=Other EPA documents *Basis of RBC: c=carcinogenic effects n=noncarcinogenic effects.*

Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
sec–Butylbenzene	135988	1.00E–02 e				***	61 n	37 n	14 n	10000 n	780 n
tert–Butylbenzene	104518	1.00E–02 e				***	61 n	37 n	14 n	10000 n	780 n
Butylphthalyl butylglycolate	85701	1.00E+00 I					37000 n	3700 n	1400 n	1000000 n	78000 n
Cacodylic acid	75605	3.00E–03 h					110 n	11 n	4.1 n	3100 n	230 n
Cadmium and compounds	7440439	5.00E–04 I			6.30E+00 I		18 n	0.00099 c	0.68 n	510 n	39 n
Caprolactam	105602	5.00E–01 I					18000 n	1800 n	680 n	510000 n	39000 n
Captafol	2425061	2.00E–03 I		8.60E–03 h			7.8 c	0.73 c	0.37 c	330 c	74 c
Captan	133062	1.30E–01 I		3.50E–03 h			19 c	1.8 c	0.9 c	820 c	180 c
Carbaryl	63252	1.00E–01 I					3700 n	370 n	140 n	100000 n	7800 n
Carbazole	86748			2.00E–02 h			3.4 c	0.31 c	0.16 c	140 c	32 c
Carbofuran	1563662	5.00E–03 I					180 n	18 n	6.8 n	5100 n	390 n
Carbon disulfide	75150	1.00E–01 I	2.86E–03 h			***	21 n	10 n	140 n	100000 n	7800 n
Carbon tetrachloride	56235	7.00E–04 I	5.71E–04 e	1.30E–01 I	5.25E–02 I	***	0.16 c	0.12 c	0.024 c	22 c	4.9 c
Carbosulfan	55285148	1.00E–02 I					370 n	37 n	14 n	10000 n	780 n
Carboxin	5234684	1.00E–01 I					3700 n	370 n	140 n	100000 n	7800 n
Chloral	75876	2.00E–03 I					73 n	7.3 n	2.7 n	2000 n	160 n
Chloramben	133904	1.50E–02 I					550 n	55 n	20 n	15000 n	1200 n
Chloranil	118752			4.03E–01 h			0.17 c	0.016 c	0.0078 c	7.1 c	1.6 c
Chlordane	57749	6.00E–05 I		1.30E+00 I	1.29E+00 I		0.052 c	0.0049 c	0.0024 c	2.2 c	0.49 c
Chlorimuron–ethyl	90982324	2.00E–02 I					730 n	73 n	27 n	20000 n	1600 n
Chlorine dioxide	10049044		5.71E–05 I				2.1 n	0.21 n			
Chloroacetaldehyde	107200	6.90E–03 o					250 n	25 n	9.3 n	7100 n	540 n
Chloroacetic acid	79118	2.00E–03 h					73 n	7.3 n	2.7 n	2000 n	160 n
2–Chloroacetophenone	532274		8.57E–06 I				0.31 n	0.031 n			
4–Chloroaniline	106478	4.00E–03 I					150 n	15 n	5.4 n	4100 n	310 n
Chlorobenzene	108907	2.00E–02 I	5.71E–03 a			***	39 n	21 n	27 n	20000 n	1600 n
Chlorobenzilate	510156	2.00E–02 I		2.70E–01 h	2.70E–01 h		0.25 c	0.023 c	0.012 c	11 c	2.4 c
p–Chlorobenzoic acid	74113	2.00E–01 h					7300 n	730 n	270 n	200000 n	16000 n
4–Chlorobenzotrifluoride	98566	2.00E–02 h					730 n	73 n	27 n	20000 n	1600 n
2–Chloro–1,3–butadiene	126998	2.00E–02 a	2.00E–03 h			***	14 n	7.3 n	27 n	20000 n	1600 n
1–Chlorobutane	109693	4.00E–01 h				***	2400 n	1500 n	540 n	410000 n	31000 n
Chlorodifluoromethane	75456		1.43e+01 I			***	87000 n	52000 n			
Chloroethane	75003	4.00E–01 a	2.86E+00 I			***	8600 n	10000 n	540 n	410000 n	31000 n
2–Chloroethyl vinyl ether	110758	2.50E–02 o				***	150 n	91 n	34 n	26000 n	2000 n
Chloroform	67663	1.00E–02 I		6.10E–03 I	8.05E–02 I	***	0.15 c	0.078 c	0.52 c	470 c	100 c
Chloromethane	74873			1.30E–02 h	6.30E–03 h	***	1.4 c	0.99 c	0.24 c	220 c	49 c
4–Chloro–2,2–methylaniline hydrochloride	3165933			4.60E–01 h			0.15 c	0.014 c	0.0069 c	6.2 c	1.4 c
4–Chloro–2–methylaniline	95692			5.80E–01 h			0.12 c	0.011 c	0.0054 c	4.9 c	1.1 c
beta–Chloronaphthalene	91587	8.00E–02 I					2900 n	290 n	110 n	82000 n	6300 n
o–Chloronitrobenzene	88733			2.50E–02 h		***	0.42 c	0.25 c	0.13 c	110 c	26 c
p–Chloronitrobenzene	121733			1.80E–02 h		***	0.59 c	0.35 c	0.18 c	160 c	35 c
2–Chlorophenol	95578	5.00E–03 I					180 n	18 n	6.8 n	5100 n	390 n

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
2-Chloropropane	75296		2.86E-02 *h*			***	170 *n*	100 *n*			
Chlorothalonil	1897456	1.50E-02 *i*		1.10E-02 *h*			6.1 *c*	0.57 *c*	0.29 *c*	260 *c*	58 *c*
o-Chlorotoluene	95498	2.00E-02 *i*				***	120 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Chlorpropham	101213	2.00E-01 *i*					7300 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
Chlorpyrifos	2921882	3.00E-03 *i*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
Chlorpyrifos-methyl	5598130	1.00E-02 *h*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Chlorsulfuron	64902723	5.00E-02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Chlorthiophos	60238564	8.00E-04 *h*					29 *n*	2.9 *n*	1.1 *n*	820 *n*	63 *n*
Chromium III and compounds	16065831	1.00E+00 *i*	5.71E-07 *w*				37000 *n*	0.0021 *n*	1400 *n*	1000000 *n*	78000 *n*
Chromium VI and compounds	7440473	5.00E-03 *i*			4.20E+01 *i*		180 *n*	0.00015 *c*	6.8 *n*	5100 *n*	390 *n*
Coal tar	8001589				2.20E+00 *w*			0.0028 *c*			
Cobalt	7440484	1.80E-01 *e*					6600 *n*	660 *n*	240 *n*	180000 *n*	14000 *n*
Coke Oven Emissions	8007452				2.17E+00 *i*			0.0029 *c*			
Copper and compounds	7440508	3.71E-02 *h*					1400 *n*	140 *n*	50 *n*	38000 *n*	2900 *n*
Crotonaldehyde	123739	1.00E-02 *w*		1.90E+00 *h*	1.90E+00 *w*		0.035 *c*	0.0033 *c*	0.0017 *c*	1.5 *c*	0.34 *c*
Cumene	98828	4.00E-02 *i*	2.57E-03 *h*				1500 *n*	9.4 *n*	54 *n*	41000 *n*	3100 *n*
Cyanides:											
Barium cyanide	542621	1.00E-01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Calcium cyanide	592018	4.00E-02 *i*					1500 *n*	150 *n*	54 *n*	41000 *n*	3100 *n*
Copper cyanide	544923	5.00E-03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Cyanazine	21725462	2.00E-03 *h*		8.40E-01 *h*			0.08 *c*	0.0075 *c*	0.0038 *c*	3.4 *c*	0.76 *c*
Cyanogen	460195	4.00E-02 *i*					1500 *n*	150 *n*	54 *n*	41000 *n*	3100 *n*
Cyanogen bromide	506683	9.00E-02 *i*					3300 *n*	330 *n*	120 *n*	92000 *n*	7000 *n*
Cyanogen chloride	506774	5.00E-02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Free cyanide	57125	2.00E-02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Hydrogen cyanide	74908	2.00E-02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Potassium cyanide	151508	5.00E-02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Potassium silver cyanide	506616	2.00E-01 *i*					7300 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
Silver cyanide	506649	1.00E-01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Sodium cyanide	143339	4.00E-02 *i*					1500 *n*	150 *n*	54 *n*	41000 *n*	3100 *n*
Zinc cyanide	557211	5.00E-02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Cyclohexanone	108941	5.00E+00 *i*				***	30000 *n*	18000 *n*	6800 *n*	1000000 *n*	390000 *n*
Cyclohexlamine	108918	2.00E-01 *i*					7300 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
Cyhalothrin/Karate	68085858	5.00E-03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Cypermethrin	52315078	1.00E-02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Cyromazine	66215278	7.50E-03 *i*					270 *n*	27 *n*	10 *n*	7700 *n*	590 *n*
Dacthal	1861321	5.00E-01 *i*					18000 *n*	1800 *n*	680 *n*	510000 *n*	39000 *n*
Dalapon	75990	3.00E-02 *i*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
Danitol	39515418	5.00E-04 *w*					18 *n*	1.8 *n*	0.68 *n*	510 *n*	39 *n*
DDD	72548			2.40E-01 *i*			0.28 *c*	0.026 *c*	0.013 *c*	12 *c*	2.7 *c*
DDE	72559			3.40E-01 *i*			0.2 *c*	0.018 *c*	0.0093 *c*	8.4 *c*	1.9 *c*
DDT	50293	5.00E-04 *i*		3.40E-01 *i*	3.40E-01 *i*		0.2 *c*	0.018 *c*	0.0093 *c*	8.4	1.9 *c*

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg*d/mg	CPSi kg*d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Decabromodiphenyl ether	1163195	1.00E–02 *i*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Demeton	8065483	4.00E–05 *i*					1.5 *n*	0.15 *n*	0.054 *n*	41 *n*	3.1 *n*
Diallate	2303164			6.10E–02 *h*		***	0.17 *c*	0.1 *c*	0.052 *c*	47 *c*	10 *c*
Diazinon	333415	9.00E–04 *h*					33 *n*	3.3 *n*	1.2 *n*	920 *n*	70 *n*
1,4–Dibromobenzene	106376	1.00E–02 *i*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Dibromochloromethane	124481	2.00E–02 *i*		8.40E–02 *i*		***	0.13 *c*	0.075 *c*	0.038 *c*	34 *c*	7.6 *c*
1,2–Dibromo–3–chloropropane	96128		5.71E–05 *i*	1.40E+00 *h*	2.42E–03 *h*	***	0.048 *c*	0.21 *n*	0.0023 *c*	2 *c*	0.46 *c*
1,2–Dibromoethane	106934		5.71E–05 *h*	8.50E+01 *i*	7.70E–01 *i*	***	0.00075 *c*	0.0081 *c*	0.000037 *c*	0.034 *c*	0.0075 *c*
Dibutyl phthalate	84742	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Dicamba	1918009	3.00E–02 *i*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
1,2–Dichlorobenzene	95501	9.00E–02 *i*	5.71E–02 *a*			***	370 *n*	210 *n*	120 *n*	92000 *n*	7000 *n*
1,3–Dichlorobenzene	541731	8.90E–02 *o*				***	540 *n*	320 *n*	120 *n*	91000 *n*	7000 *n*
1,4–Dichlorobenzene	106467		2.29E–01 *i*	2.40E–02 *h*		***	0.44 *c*	0.26 *c*	0.13 *c*	120 *c*	27 *c*
3,3'–Dichlorobenzidine	91941			4.50E–01 *i*			0.15 *c*	0.014 *c*	0.007 *c*	6.4 *c*	1.4 *c*
1,4–Dichloro–2–butene	764410				9.30E+00 *h*	***	0.0011 *c*	0.00067 *c*			
Dichlorodifluoromethane	75718	2.00E–01 *i*	5.71E–02 *a*			***	390 *n*	210 *n*	270 *n*	200000 *n*	16000 *n*
1,1–Dichloroethane	75343	1.00E–01 *h*	1.43E–01 *a*			***	810 *n*	520 *n*	140 *n*	100000 *n*	7800 *n*
1,2–Dichloroethane (EDC)	107062		2.86E–03 *e*	9.10E–02 *i*	9.10E–02 *i*	***	0.12 *c*	0.069 *c*	0.035 *c*	31 *c*	7 *c*
1,1–Dichloroethylene	75354	9.00E–03 *i*		6.00E–01 *i*	1.75E–01 *i*	***	0.044 *c*	0.036 *c*	0.0053 *c*	4.8 *c*	1.1 *c*
1,2–Dichloroethylene (cis)	156592	1.00E–02 *h*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
1,2–Dichloroethylene (trans)	156605	2.00E–02 *i*				***	120 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
1,2–Dichloroethylene (mixture)	540590	9.00E–03 *h*				***	55 *n*	33 *n*	12 *n*	9200 *n*	700 *n*
2,4–Dichlorophenol	120832	3.00E–03 *i*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
2,4–Dichlorophenoxyacetic Acid (2,4–D)	94757	1.00E–02 *i*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
4–(2,4–Dichlorophenoxy)butyric Acid	94826	8.00E–03 *i*					290 *n*	29 *n*	11 *n*	8200 *n*	630 *n*
1,2–Dichloropropane	78875		1.14E–03 *i*	6.80E–02 *h*		***	0.16 *c*	0.092 *c*	0.046 *c*	42 *c*	9.4 *c*
2,3–Dichloropropanol	616239	3.00E–03 *i*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
1,3–Dichloropropene	542756	3.00E–04 *i*	5.71E–03 *i*	1.75E–01 *h*	1.30E–01 *h*	***	0.077 *c*	0.048 *c*	0.018 *c*	16 *c*	3.7 *c*
Dichlorvos	62737	5.00e–04 *i*		2.90E–01 *i*			0.23 *c*	0.022 *c*	0.011 *c*	9.9 *c*	2.2 *c*
Dicofol	115322			4.40E–01 *w*			0.15 *c*	0.014 *c*	0.0072 *c*	6.5 *c*	1.5 *c*
Dicyclopentadiene	77736	3.00E–02 *h*	5.71E–05 *a*			***	0.42 *n*	0.21 *n*	41 *n*	31000 *n*	2300 *n*
Dieldrin	60571	5.00E–05 *i*		1.60E+01 *i*	1.61E+01 *i*		0.0042 *c*	0.00039 *c*	0.0002 *c*	0.18 *c*	0.04 *c*
Diesel emissions			1.43E–03 *i*				52 *n*	5.2 *n*			
Diethyl phthalate	84662	8.00E–01 *i*					29000 *n*	2900 *n*	1100 *n*	820000 *n*	63000 *n*
Diethylene glycol, monobutyl ether	112345		5.71E–03 *h*				210 *n*	21 *n*			
Diethylene glycol, monoethyl ether	111900	2.00E+00 *h*					73000 *n*	7300 *n*	2700 *n*	1000000 *n*	160000 *n*
Diethylforamide	617845	1.10E–02 *h*					400 *n*	40 *n*	15 *n*	11000 *n*	860 *n*
Di(2–ethylhexyl)adipate	103231	6.00E–01 *i*		1.20E–03 *i*			56 *c*	5.2 *c*	2.6 *c*	2400 *c*	530 *c*
Diethylstilbestrol	56531			4.70E+03 *h*			0.000014 *c*	1.30E–06 *c*	6.70E–07 *c*	0.00061 *c*	0.00014 *c*
Difenzoquat (Avenge)	43222486	8.00E–02 *i*					2900 *n*	290 *n*	110 *n*	82000 *n*	6300 *n*
Diflubenzuron	35367385	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Diisopropyl methylphosphonate (DIMP)	1445756	8.00E–02 *i*					2900 *n*	290 *n*	110 *n*	82000 *n*	6300 *n*

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Dimethipin	55290647	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Dimethoate	60515	2.00E–04 *i*					7.3 *n*	0.73 *n*	0.27 *n*	200 *n*	16 *n*
3,3'–Dimethoxybenzidine	119904			1.40E–02 *h*			4.8 *c*	0.45 *c*	0.23 *c*	200 *c*	46 *c*
Dimethyl phthalate	131113	1.00E+01 *h*					370000 *n*	37000 *n*	14000 *n*	1000000 *n*	780000 *n*
Dimethyl terephthalate	120616	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Dimethylamine	124403		5.71E–06 *w*				0.21 *n*	0.021 *n*			
2,4–Dimethylaniline hydrochloride	21436964			5.80E–01 *h*			0.12 *c*	0.011 *c*	0.0054 *c*	4.9 *c*	1.1 *c*
2,4–Dimethylaniline	95681			7.50E–01 *h*			0.09 *c*	0.0083 *c*	0.0042 *c*	3.8 *c*	0.85 *c*
N–N–Dimethylaniline	121697	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
3,3'–Dimethylbenzidine	119937			9.20E+00 *h*			0.0073 *c*	0.00068 *c*	0.00034 *c*	0.31 *c*	0.069 *c*
N,N–Dimethylformamide	68122	1.00E–01 *h*	8.57E–03 *i*				3700 *n*	31 *n*	140 *n*	100000 *n*	7800 *n*
1,1–Dimethylhydrazine	57147			2.60E+00 *h*	3.50E+00 *h*		0.026 *c*	0.0018 *c*	0.0012 *c*	1.1 *c*	0.25 *c*
1,2–Dimethylhydrazine	540738			3.70E+01 *w*	3.70E+01 *w*		0.0018 *c*	0.00017 *c*	0.000085 *c*	0.077 *c*	0.017 *c*
2,4–Dimethylphenol	105679	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
2,6–Dimethylphenol	576261	6.00E–04 *i*					22 *n*	2.2 *n*	0.81 *n*	610 *n*	47 *n*
3,4–Dimethylphenol	95658	1.00E–03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
1,2–Dinitrobenzene	528290	4.00E–04 *h*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
1,3–Dinitrobenzene	99650	1.00E–04 *i*					3.7 *n*	0.37 *n*	0.14 *n*	100 *n*	7.8 *n*
1,4–Dinitrobenzene	100254	4.00E–04 *h*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
4,6–Dinitro–o–cyclohexyl phenol	131895	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
2,4–Dinitrophenol	51285	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Dinitrotoluene mixture				6.80E–01 *i*			0.099 *c*	0.0092 *c*	0.0046 *c*	4.2 *c*	0.94 *c*
2,4–Dinitrotoluene	121142	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
2,6–Dinitrotoluene	606202	1.00E–03 *h*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
Dinoseb	88857	1.00E–03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
di–n–Octyl phthalate	117840	2.00E–02 *h*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
1,4–Dioxane	123911			1.10E–02 *i*			6.1 *c*	0.57 *c*	0.29 *c*	260 *c*	58 *c*
Diphenamid	957517	3.00E–02 *i*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
Diphenylamine	122394	2.50E–02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
1,2–Diphenylhydrazine	122667			8.00E–01 *i*	7.70E–01 *i*		0.084 *c*	0.0081 *c*	0.0039 *c*	3.6 *c*	0.8 *c*
Diquat	85007	2.20E–03 *i*					80 *n*	8 *n*	3 *n*	2200 *n*	170 *n*
Direct black 38	1937377			8.60E+00 *h*			0.0078 *c*	0.00073 *c*	0.00037 *c*	0.33 *c*	0.074 *c*
Direct blue 6	2602462			8.10E+00 *h*			0.0083 *c*	0.00077 *c*	0.00039 *c*	0.35 *c*	0.079 *c*
Direct brown 95	16071866			9.30E+00 *h*			0.0072 *c*	0.00067 *c*	0.00034 *c*	0.31 *c*	0.069 *c*
Disulfoton	298044	4.00E–05 *i*					1.5 *n*	0.15 *n*	0.054 *n*	41 *n*	3.1 *n*
1,4–Dithiane	505293	1.00E–02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Diuron	330541	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Dodine	2439103	4.00E–03 *i*					150 *n*	15 *n*	5.4 *n*	4100 *n*	310 *n*
Endosulfan	115297	6.00E–03 *h*					220 *n*	22 *n*	8.1 *n*	6100 *n*	470 *n*
Endothall	145733	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Endrin	72208	3.00E–04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Epichlorc in	106898	2.00E–03 *h*	2.86E–04	9.90E–03 *i*	4.20E–03 *i*		6.8 *c*	1 *n*	0.32 *c*	290	65 *c*

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1,2-Epoxybutane	106887		5.71E-03 *i*				210 *n*	21 *n*			
Ethephon (2-chloroethyl phosphonic acid)	16672870	5.00E-03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Ethion	563122	5.00E-04 *i*					18 *n*	1.8 *n*	0.68 *n*	510 *n*	39 *n*
2-Ethoxyethanol acetate	111159	3.00E-01 *a*					11000 *n*	1100 *n*	410 *n*	310000 *n*	23000 *n*
2-Ethoxyethanol	110805	4.00E-01 *h*	5.71E-02 *i*				15000 *n*	210 *n*	540 *n*	410000 *n*	31000 *n*
Ethyl acrylate	140885			4.80E-02 *h*			1.4 *c*	0.13 *c*	0.066 *c*	60 *c*	13 *c*
EPTC (S-Ethyl dipropylthiocarbamate)	759944	2.50E-02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
Ethyl ether	60297	2.00E-01 *i*				***	1200 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
Ethyl methacrylate	97632	9.00E-02 *h*					3300 *n*	330 *n*	120 *n*	92000 *n*	7000 *n*
Ethyl acetate	141786	9.00E-01 *i*					33000 *n*	3300 *n*	1200 *n*	920000 *n*	70000 *n*
Ethylbenzene	100414	1.00E-01 *i*	2.86E-01 *i*			***	1300 *n*	1000 *n*	140 *n*	100000 *n*	7800 *n*
Ethylene cyanohydrin	109784	3.00E-01 *h*					11000 *n*	1100 *n*	410 *n*	310000 *n*	23000 *n*
Ethylene diamine	107153	2.00E-02 *h*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Ethylene glycol	107211	2.00E+00 *i*					73000 *n*	7300 *n*	2700 *n*	1000000 *n*	160000 *n*
Ethylene glycol, monobutyl ether	111762		5.71E-03 *h*				210 *n*	21 *n*			
Ethylene oxide	75218			1.02E+00 *h*	3.50E-01 *h*		0.066 *c*	0.018 *c*	0.0031 *c*	2.8 *c*	0.63 *c*
Ethylene thiourea (ETU)	96457	8.00E-05 *i*		1.19E-01 *h*			0.57 *c*	0.053 *c*	0.027 *c*	24 *c*	5.4 *c*
Ethyl p-nitrophenyl phenylphosphorothioate	2104645	1.00E-05 *i*					0.37 *n*	0.037 *n*	0.014 *n*	10 *n*	0.78 *n*
Ethylnitrosourea	759739			1.40E+02 *w*			0.00048 *c*	0.000045 *c*	0.000023 *c*	0.02 *c*	0.0046 *c*
Ethylphthalyl ethyl glycolate	84720	3.00E+00 *i*					110000 *n*	11000 *n*	4100 *n*	1000000 *n*	230000 *n*
Express	10120	8.00E-03 *i*					290 *n*	29 *n*	11 *n*	8200 *n*	630 *n*
Fenamiphos	22224926	2.50E-04 *i*					9.1 *n*	0.91 *n*	0.34 *n*	260 *n*	20 *n*
Fluometuron	2164172	1.30E-02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
Fluoride	7782414	6.00E-02 *i*					2200 *n*	220 *n*	81 *n*	61000 *n*	4700 *n*
Fluoridone	59756604	8.00E-02 *i*					2900 *n*	290 *n*	110 *n*	82000 *n*	6300 *n*
Flurprimidol	56425913	2.00E-02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Flutolanil	66332965	6.00E-02 *i*					2200 *n*	220 *n*	81 *n*	61000 *n*	4700 *n*
Fluvalinate	69409945	1.00E-02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Folpet	133073	1.00E-01 *i*		3.50E-03 *i*			19 *c*	1.8 *c*	0.9 *c*	820 *c*	180 *c*
Fomesafen	72178020			1.90E-01 *i*			0.35 *c*	0.033 *c*	0.017 *c*	15 *c*	3.4 *c*
Fonofos	944229	2.00E-03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Formaldehyde	50000	2.00E-01 *i*			4.55E-02 *i*		7300 *n*	0.14 *c*	270 *n*	200000 *n*	16000 *n*
Formic Acid	64186	2.00E+00 *h*					73000 *n*	7300 *n*	2700 *n*	1000000 *n*	160000 *n*
Fosetyl-al	39148248	3.00E+00 *i*					110000 *n*	11000 *n*	4100 *n*	1000000 *n*	230000 *n*
Furan	110009	1.00E-03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
Furazolidone	67458			3.80E+00 *h*			0.018 *c*	0.0016 *c*	0.00083 *c*	0.75 *c*	0.17 *c*
Furfural	98011	3.00E-03 *i*	1.43E-02 *a*				110 *n*	52 *n*	4.1 *n*	3100 *n*	230 *n*
Furium	531828			5.00E+01 *h*			0.0013 *c*	0.00013 *c*	0.000063 *c*	0.057 *c*	0.013 *c*
Furmecyclox	60568050			3.00E-02 *i*			2.2 *c*	0.21 *c*	0.11 *c*	95 *c*	21 *c*
Glufosinate-ammonium	77182822	4.00E-04 *i*					15 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
Glycidaldehyde	765344	4.00E-04 *i*	2.86E-04 *h*				15 *n*	1 *n*	0.54 *n*	410 *n*	31 *n*
Glyphosate	1071836	1.00E-01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*

Sources: i=IRIS h=HEAST a=HEAST alt. w=Withdrawn from IRIS or HEAST e=EPA-ECAO o=Other EPA documents *Basis of RBC: c=carcinogenic effects n=noncarcinogenic effects.*

Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Haloxyfop-methyl	69806402	5.00E-05 *i*					1.8 *n*	0.18 *n*	0.068 *n*	51 *n*	3.9 *n*
Harmony	79277273	1.30E-02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
HCH (alpha)	319846			6.30E+00 *i*	6.30E+00 *i*		0.011 *c*	0.00099 *c*	0.0005 *c*	0.45 *c*	0.1 *c*
HCH (beta)	319857			1.80E+00 *i*	1.80E+00 *i*		0.037 *c*	0.0035 *c*	0.0018 *c*	1.6 *c*	0.35 *c*
HCH (gamma) Lindane	58899	3.00E-04 *i*		1.30E+00 *h*			0.052 *c*	0.0048 *c*	0.0024 *c*	2.2 *c*	0.49 *c*
HCH-technical	608731			1.80E+00 *i*	1.79E+00 *i*		0.037 *c*	0.0035 *c*	0.0018 *c*	1.6 *c*	0.35 *c*
Heptachlor	76448	5.00E-04 *i*		4.50E+00 *i*	4.55E+00 *i*	***	0.0023 *c*	0.0014 *c*	0.0007 *c*	0.64 *c*	0.14 *c*
Heptachlor epoxide	1024573	1.30E-05 *i*		9.10E+00 *i*	9.10E+00 *i*	***	0.0012 *c*	0.00069 *c*	0.00035 *c*	0.31 *c*	0.07 *c*
Hexabromobenzene	87821	2.00E-03 *i*				***	12 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Hexachlorobenzene	118741	8.00E-04 *i*		1.60E+00 *i*	1.61E+00 *i*	***	0.0066 *c*	0.0039 *c*	0.002 *c*	1.8 *c*	0.4 *c*
Hexachlorobutadiene	87683	2.00E-04 *h*		7.80E-02 *i*	7.70E-02 *i*	***	0.14 *c*	0.081 *c*	0.04 *c*	37 *c*	8.2 *c*
Hexachlorocyclopentadiene	77474	7.00E-03 *i*	2.00E-05 *h*			***	0.15 *n*	0.073 *n*	9.5 *n*	7200 *n*	550 *n*
Hexachlorodibenzo-p-dioxin mixture	19408743			6.20E+03 *i*	4.55E+03 *i*		0.000011 *c*	1.40E-06 *c*	5.10E-07 *c*	0.00046 *c*	0.0001 *c*
Hexachloroethane	67721	1.00E-03 *i*		1.40E-02 *i*	1.40E-02 *i*	***	0.75 *c*	0.45 *c*	0.23 *c*	200 *c*	46 *c*
Hexachlorophene	70304	3.00E-04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121824	3.00E-03 *i*		1.10E-01 *i*			0.61 *c*	0.057 *c*	0.029 *c*	26 *c*	5.8 *c*
n-Hexane	110543	6.00E-02 *h*	5.71E-02 *i*			***	350 *n*	210 *n*	81 *n*	61000 *n*	4700 *n*
Hexazinone	51235042	3.30E-02 *i*					1200 *n*	120 *n*	45 *n*	34000 *n*	2600 *n*
Hydrazine, hydrazine sulfate	302012			3.00E+00 *i*	1.71E+01 *i*		0.022 *c*	0.00037 *c*	0.0011 *c*	0.95 *c*	0.21 *c*
Hydrogen chloride	7647010		2.00E-03 *i*				73 *n*	7.3 *n*			
Hydrogen sulfide	7783064	3.00E-03 *i*	2.57E-04 *i*				110 *n*	0.94 *n*	4.1 *n*	3100 *n*	230 *n*
Hydroquinone	123319	4.00E-02 *h*					1500 *n*	150 *n*	54 *n*	41000 *n*	3100 *n*
Imazalil	35554440	1.30E-02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
Imazaquin	81335377	2.50E-01 *i*					9100 *n*	910 *n*	340 *n*	260000 *n*	20000 *n*
Iprodione	36734197	4.00E-02 *i*					1500 *n*	150 *n*	54 *n*	41000 *n*	3100 *n*
Isobutanol	78831	3.00E-01 *i*				***	1800 *n*	1100 *n*	410 *n*	310000 *n*	23000 *n*
Isophorone	78591	2.00E-01 *i*		9.50E-04 *i*			71 *c*	6.6 *c*	3.3 *c*	3000 *c*	670 *c*
Isopropalin	33820530	1.50E-02 *i*					550 *n*	55 *n*	20 *n*	15000 *n*	1200 *n*
Isopropyl methyl phosphonic acid	1832548	1.00E-01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Isoxaben	82558507	5.00E-02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Kepone	143500			1.80E+01 *e*			0.0037 *c*	0.00035 *c*	0.00018 *c*	0.16 *c*	0.035 *c*
Lactofen	77501634	2.00E-03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Lead (tetraethyl)	78002	1.00E-07 *i*					0.0037 *n*	0.00037 *n*	0.00014 *n*	0.1 *n*	0.0078 *n*
Linuron	330552	2.00E-03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Lithium	7439932	2.00E-02 *e*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Londax	83056996	2.00E-01 *i*					7300 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
Malathion	121755	2.00E-02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Maleic anhydride	108316	1.00E-01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Maleic hydrazide	123331	5.00E-01 *i*					18000 *n*	1800 *n*	680 *n*	510000 *n*	39000 *n*
Malononitrile	109773	2.00E-05 *h*					0.73 *n*	0.073 *n*	0.027 *n*	20 *n*	1.6 *n*
Mancoze	8018017	3.00E-02 *h*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
Maneb	12427382	5.00E-03 *i*					180 *n*	18 *n*	6.8 *n*	51	390 *n*

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Manganese and compounds	7439965	5.00E-03 *i*	1.43e-05 *i*				180 *n*	0.052 *n*	6.8 *n*	5100 *n*	390 *n*
Mephosfolan	950107	9.00E-05 *h*					3.3 *n*	0.33 *n*	0.12 *n*	92 *n*	7 *n*
Mepiquat chloride	24307264	3.00E-02 *i*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
Mercury (inorganic)	7439976	3.00E-04 *h*	8.57E-05 *h*				11 *n*	0.31 *n*	0.41 *n*	310 *n*	23 *n*
Mercury (methyl)	22967926	3.00E-04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Merphos	150505	3.00E-05 *i*					1.1 *n*	0.11 *n*	0.041 *n*	31 *n*	2.3 *n*
Merphos oxide	78488	3.00E-05 *i*					1.1 *n*	0.11 *n*	0.041 *n*	31 *n*	2.3 *n*
Metalaxyl	57837191	6.00E-02 *i*					2200 *n*	220 *n*	81 *n*	61000 *n*	4700 *n*
Methacrylonitrile	126987	1.00E-04 *i*	2.00E-04 *a*				3.7 *n*	0.73 *n*	0.14 *n*	100 *n*	7.8 *n*
Methamidophos	10265926	5.00E-05 *i*					1.8 *n*	0.18 *n*	0.068 *n*	51 *n*	3.9 *n*
Methanol	67561	5.00E-01 *i*					18000 *n*	1800 *n*	680 *n*	510000 *n*	39000 *n*
Methidathion	950378	1.00E-03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
Methomyl	16752775	2.50E-02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
Methoxychlor	72435	5.00E-03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
2-Methoxyethanol acetate	110496	2.00E-03 *a*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
2-Methoxyethanol	109864	1.00E-03 *h*	5.71E-03 *i*				37 *n*	21 *n*	1.4 *n*	1000 *n*	78 *n*
2-Methoxy-5-nitroaniline	99592			4.60E-02 *h*			1.5 *c*	0.14 *c*	0.069 *c*	62 *c*	14 *c*
Methyl acetate	79209	1.00E+00 *h*					37000 *n*	3700 *n*	1400 *n*	1000000 *n*	78000 *n*
Methyl acrylate	96333	3.00E-02 *a*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
2-Methylaniline hydrochloride	636215			1.80E-01 *h*			0.37 *c*	0.035 *c*	0.018 *c*	16 *c*	3.5 *c*
2-Methylaniline	95534			2.40E-01 *h*			0.28 *c*	0.026 *c*	0.013 *c*	12 *c*	2.7 *c*
Methyl chlorocarbonate	79221	1.00E+00 *w*					37000 *n*	3700 *n*	1400 *n*	1000000 *n*	78000 *n*
4-(2-Methyl-4-chlorophenoxy) butyric acid	94815	1.00E-02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
2-Methyl-4-chlorophenoxyacetic acid	94746	5.00E-04 *i*					18 *n*	1.8 *n*	0.68 *n*	510 *n*	39 *n*
2-(2-Methyl-14-chlorophenoxy)propionic acid	93652	1.00E-03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
Methylcyclohexane	108872		8.57E-01 *h*				31000 *n*	3100 *n*			
Methylene bromide	74953	1.00E-02 *a*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Methylene chloride	75092	6.00E-02 *i*	8.57E-01 *h*	7.50E-03 *i*	1.64E-03 *i*	***	4.1 *c*	3.8 *c*	0.42 *c*	380 *c*	85 *c*
4,4'-Methylene bis(2-chloroaniline)	101144	7.00E-04 *h*		1.30E-01 *h*	1.30E-01 *h*		0.52 *c*	0.048 *c*	0.024 *c*	22 *c*	4.9 *c*
4,4'-Methylenebisbenzeneamine	101779			2.50E-01			0.27 *c*	0.025 *c*	0.013 *c*	11 *c*	2.6 *c*
4,4'-Methylene bis(N,N'-dimethyl)aniline	101611			4.60E-02 *i*			1.5 *c*	0.14 *c*	0.069 *c*	62 *c*	14 *c*
4,4'-Methylenediphenyl isocyanate	101688		5.71E-06 *h*			***	0.035 *n*	0.021 *n*			
Methyl ethyl ketone	78933	6.00E-01 *i*	2.86E-01 *i*				22000 *n*	1000 *n*	810 *n*	610000 *n*	47000 *n*
Methyl hydrazine	60344			1.10E+00 *h*			0.061 *c*	0.0057 *c*	0.0029 *c*	2.6 *c*	0.58 *c*
Methyl isobutyl ketone	108101	8.00E-02 *h*	2.29E-02 *a*				2900 *n*	84 *n*	110 *n*	82000 *n*	6300 *n*
Methyl methacrylate	80626	8.00E-02 *h*					2900 *n*	290 *n*	110 *n*	82000 *n*	6300 *n*
2-Methyl-5-nitroaniline	99558			3.30E-02 *h*			2 *c*	0.19 *c*	0.096 *c*	87 *c*	19 *c*
Methyl parathion	298000	2.50E-04 *i*					9.1 *n*	0.91 *n*	0.34 *n*	260 *n*	20 *n*
2-Methylphenol (o-cresol)	95487	5.00E-02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
3-Methylphenol (m-cresol)	103394	5.00E-02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
4-Methylphenol (p-cresol)	106445	5.00E-03 *h*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Methyl styrene (mixture)	25013154	6.00E-03 *a*	1.14E-02 *a*			***	60 *n*	42 *n*	8.1 *n*	6100 *n*	470 *n*

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	V O C	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Methyl styrene (alpha)	98839	7.00E–02 *a*				***	430 *n*	260 *n*	95 *n*	72000 *n*	5500 *n*
Methyl tertbutyl ether (MTBE)	1634044	5.00E–03 *e*	8.57E–01 *i*			***	180 *n*	3100 *n*	6.8 *n*	5100 *n*	390 *n*
Metolaclor (Dual)	51218452	1.50E–01 *h*					5500 *n*	550 *n*	200 *n*	150000 *n*	12000 *n*
Metribuzin	21807649	2.50E–02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
Mirex	2385855	2.00E–04 *i*		1.80E+00 _			0.037 *c*	0.0035 *c*	0.0018 *c*	1.6 *c*	0.35 *c*
Molinate	2212671	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Molybdenum	7439987	5.00E–03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Monochloramine	10599903	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Naled	300765	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Napropamide	15299997	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Nickel refinery dust					8.40E–01 *i*			0.0075 *c*			
Nickel (soluble salts)	7440020	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Nickel subsulfide	12035722				1.70E+00 *i*			0.0037 *c*			
Nitrapyrin	1929824	1.50E–03 *w*					55 *n*	5.5 *n*	2 *n*	1500 *n*	120 *n*
Nitrate	14797558	1.60E+00 *i*					58000 *n*	5800 *n*	2200 *n*	1000000 *n*	130000 *n*
Nitric Oxide	10102439	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
Nitrite	14797650	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
2–Nitroaniline	88744	6.00E–05 *w*	5.71E–05 *h*				2.2 *n*	0.21 *n*	0.081 *n*	61 *n*	4.7 *n*
3–Nitroaniline	99092	3.00E–03 *o*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
4–Nitroaniline	100016	3.00E–03 *o*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
Nitrobenzene	98953	5.00E–04 *i*	5.71E–04 *a*			***	3.4 *n*	2.1 *n*	0.68 *n*	510 *n*	39 *n*
Nitrofurantoin	67209	7.00E–02 *h*					2600 *n*	260 *n*	95 *n*	72000 *n*	5500 *n*
Nitrofurazone	59870			1.50E+00 *h*	9.40E+00 *h*		0.045 *c*	0.00067 *c*	0.0021 *c*	1.9 *c*	0.43 *c*
Nitrogen dioxide	10102440	1.00E+00 *i*					37000 *n*	3700 *n*	1400 *n*	1000000 *n*	78000 *n*
Nitroguanidine	556887	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
4–Nitrophenol	100027	6.20E–02 *o*					2300 *n*	230 *n*	84 *n*	63000 *n*	4800 *n*
2–Nitropropane	79469		5.71E–03 *i*		9.40E+00 *h*		210 *n*	0.00067 *c*			
N–Nitrosodi–n–butylamine	924163			5.40E+00 *i*	5.60E+00 *i*		0.012 *c*	0.0011 *c*	0.00058 *c*	0.53 *c*	0.12 *c*
N–Nitrosodiethanolamine	1116547			2.80E+00 *i*			0.024 *c*	0.0022 *c*	0.0011 *c*	1 *c*	0.23 *c*
N–Nitrosodiethylamine	55185			1.50E+02 *i*	1.51E+02 *i*		0.00045 *c*	0.000041 *c*	0.000021 *c*	0.019 *c*	0.0043 *c*
N–Nitrosodimethylamine	62759			5.10E+01 *i*	4.90E+01 *i*		0.0013 *c*	0.00013 *c*	0.000062 *c*	0.056 *c*	0.013 *c*
N–Nitrosodiphenylamine	86306			4.90E–03 *i*			14 *c*	1.3 *c*	0.64 *c*	580 *c*	130 *c*
N–Nitroso di–n–propylamine	621647			7.00E+00 *i*			0.0096 *c*	0.00089 *c*	0.00045 *c*	0.41 *c*	0.091 *c*
N–Nitroso–N–methylethylamine	10595956			2.20E+01 *i*			0.0031 *c*	0.00028 *c*	0.00014 *c*	0.13 *c*	0.029 *c*
N–Nitrosopyrrolidine	930552			2.10E+00 *i*	2.13E+00 *i*		0.032 *c*	0.0029 *c*	0.0015 *c*	1.4 *c*	0.3 *c*
m–Nitrotoluene	99081	1.00E–02 *h*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
o–Nitrotoluene	88722	1.00E–02 *h*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
p–Nitrotoluene	99990	1.00E–02 *h*				***	61 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Norflurazon	27314132	4.00E–02 *i*					1500 *n*	150 *n*	54 *n*	41000 *n*	3100 *n*
NuStar	85509199	7.00E–04 *i*					26 *n*	2.6 *n*	0.95 *n*	720 *n*	55 *n*
Octabrom[illegible]phenyl ether	32536520	3.00E–03 *i*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
Octahydr[illegible]357–tetranitro–1357–tetrazocine	2691410	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	5100[illegible]	3900 *n*

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Octamethylpyrophosphoramide	152169	2.00E–03 *h*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Oryzalin	19044883	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Oxadiazon	19666309	5.00E–03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Oxamyl	23135220	2.50E–02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
Oxyfluorfen	42874033	3.00E–03 *i*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
Paclobutrazol	76738620	1.30E–02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
Paraquat	1910425	4.50E–03 *i*					160 *n*	16 *n*	6.1 *n*	4600 *n*	350 *n*
Parathion	56382	6.00E–03 *h*					220 *n*	22 *n*	8.1 *n*	6100 *n*	470 *n*
Pebulate	1114712	5.00E–02 *h*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Pendimethalin	40487421	4.00E–02 *i*					1500 *n*	150 *n*	54 *n*	41000 *n*	3100 *n*
Pentabromo–6–chloro cyclohexane	87843			2.30E–02 *h*			2.9 *c*	0.27 *c*	0.14 *c*	120 *c*	28 *c*
Pentabromodiphenyl ether	32534819	2.00E–03 *i*					73 *n*	7.3 *n*	2.7 *n*	2000 *n*	160 *n*
Pentachlorobenzene	608935	8.00E–04 *i*				***	4.9 *n*	2.9 *n*	1.1 *n*	820 *n*	63 *n*
Pentachloronitrobenzene	82688	3.00E–03 *i*		2.60E–01 *h*		***	0.041 *c*	0.024 *c*	0.012 *c*	11 *c*	2.5 *c*
Pentachlorophenol	87865	3.00E–02 *i*		1.20E–01 *i*			0.56 *c*	0.052 *c*	0.026 *c*	24 *c*	5.3 *c*
Permethrin	52645531	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	51000 *n*	3900 *n*
Phenmedipham	13684634	2.50E–01 *i*					9100 *n*	910 *n*	340 *n*	260000 *n*	20000 *n*
Phenol	108952	6.00E–01 *i*					22000 *n*	2200 *n*	810 *n*	610000 *n*	47000 *n*
m–Phenylenediamine	108452	6.00E–03 *i*					220 *n*	22 *n*	8.1 *n*	6100 *n*	470 *n*
o–Phenylenediamine	95545	6.00E–03 *h*					220 *n*	22 *n*	8.1 *n*	6100 *n*	470 *n*
p–Phenylenediamine	106503	1.90E–01 *h*					6900 *n*	690 *n*	260 *n*	190000 *n*	15000 *n*
Phenylmercuric acetate	62384	8.00E–05 *i*					2.9 *n*	0.29 *n*	0.11 *n*	82 *n*	6.3 *n*
2–Phenylphenol	90437			1.94E–03 *h*			35 *c*	3.2 *c*	1.6 *c*	1500 *c*	330 *c*
Phorate	298022	2.00E–04 *h*					7.3 *n*	0.73 *n*	0.27 *n*	200 *n*	16 *n*
Phosmet	732116	2.00E–02 *i*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Phosphine	7803512	3.00E–04 *i*	8.57E–06 *h*				11 *n*	0.031 *n*	0.41 *n*	310 *n*	23 *n*
Phosphorus (white)	7723140	2.00E–05 *i*					0.73 *n*	0.073 *n*	0.027 *n*	20 *n*	1.6 *n*
p–Phthalic acid	100210	1.00E+00 *h*					37000 *n*	3700 *n*	1400 *n*	1000000 *n*	78000 *n*
Phthalic anhydride	85449	2.00E+00 *i*	3.43E–01 *h*				73000 *n*	1300 *n*	2700 *n*	1000000 *n*	160000 *n*
Picloram	1918021	7.00E–02 *i*					2600 *n*	260 *n*	95 *n*	72000 *n*	5500 *n*
Pirimiphos–methyl	29232937	1.00E–02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
Polybrominated biphenyls		7.00E–06 *h*		8.90E+00 *h*			0.0076 *c*	0.0007 *c*	0.00035 *c*	0.32 *c*	0.072 *c*
Polychlorinated biphenyls (PCBs)	1336363			7.70E+00 *i*			0.0087 *c*	0.00081 *c*	0.00041 *c*	0.37 *c*	0.083 *c*
Aroclor 1016	12674112	7.00E–05 *i*					2.6 *n*	0.26 *n*	0.095 *n*	72 *n*	5.5 *n*
Polychlorinated terphenyls (PCTs)				4.50E+00 *e*			0.015 *c*	0.0014 *c*	0.0007 *c*	0.64 *c*	0.14 *c*
Polynuclear aromatic hydrocarbons											
Acenaphthene	83329	6.00E–02 *i*					2200 *n*	220 *n*	81 *n*	61000 *n*	4700 *n*
Anthracene	120127	3.00E–01 *i*					11000 *n*	1100 *n*	410 *n*	310000 *n*	23000 *n*
Benzo[a]pyrene	50328			7.30E+00 *i*	6.10E+00 *h*		0.0092 *c*	0.001 *c*	0.00043 *c*	0.39 *c*	0.088 *c*
Benzo[b]fluoranthene	205992			7.30E–01 *e*	6.10E–01 *e*		0.092 *c*	0.01 *c*	0.0043 *c*	3.9 *c*	0.88 *c*
Benzo[k]fluoranthene	207089			7.30E–02 *e*	6.10E–02 *e*		0.92 *c*	0.1 *c*	0.043 *c*	39 *c*	8.8 *c*
Benz[a]anthracene	56553			7.30E–01 *e*	6.10E–01 *e*		0.092 *c*	0.01 *c*	0.0043 *c*	3.9 *c*	0.88 *c*

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	V O C	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Chrysene	218019			7.30E–03 e	6.10E–03 e		9.2 c	1 c	0.43 c	390 c	88 c
Dibenz[ah]anthracene	53703			7.30E+00 e	6.10E+00 e		0.0092 c	0.001 c	0.00043 c	0.39 c	0.088 c
Fluoranthene	206440	4.00E–02 i					1500 n	150 n	54 n	41000 n	3100 n
Fluorene	86737	4.00E–02 i					1500 n	150 n	54 n	41000 n	3100 n
Indeno[1,2,3–cd]pyrene	193395			7.30E–01 e	6.10E–01 e		0.092 c	0.01 c	0.0043 c	3.9 c	0.88 c
Naphthalene	91203	4.00E–02 w					1500 n	150 n	54 n	41000 n	3100 n
Pyrene	129000	3.00E–02 i					1100 n	110 n	41 n	31000 n	2300 n
Prochloraz	67747095	9.00E–03 i		1.50E–01 i			0.45 c	0.042 c	0.021 c	19 c	4.3 c
Profluralin	26399360	6.00E–03 h					220 n	22 n	8.1 n	6100 n	470 n
Prometon	1610180	1.50E–02 i					550 n	55 n	20 n	15000 n	1200 n
Prometryn	7287196	4.00E–03 i					150 n	15 n	5.4 n	4100 n	310 n
Pronamide	23950585	7.50E–02 i					2700 n	270 n	100 n	77000 n	5900 n
Propachlor	1918167	1.30E–02 i					470 n	47 n	18 n	13000 n	1000 n
Propanil	709988	5.00E–03 i					180 n	18 n	6.8 n	5100 n	390 n
Propargite	2312358	2.00E–02 i					730 n	73 n	27 n	20000 n	1600 n
Propargyl alcohol	107197	2.00E–03 i					73 n	7.3 n	2.7 n	2000 n	160 n
Propazine	139402	2.00E–02 i					730 n	73 n	27 n	20000 n	1600 n
Propham	122429	2.00E–02 i					730 n	73 n	27 n	20000 n	1600 n
Propiconazole	60207901	1.30E–02 i					470 n	47 n	18 n	13000 n	1000 n
Propylene glycol	57556	2.00E+01 h					730000 n	73000 n	27000 n	1000000 n	1000000 n
Propylene glycol, monoethyl ether	52125538	7.00E–01 h					26000 n	2600 n	950 n	720000 n	55000 n
Propylene glycol, monomethyl ether	107982	7.00E–01 h	5.71E–01 i				26000 n	2100 n	950 n	720000 n	55000 n
Propylene oxide	75569		8.57E–03 i	2.40E–01 i	1.29E–02 i		0.28 c	0.49 c	0.013 c	12 c	2.7 c
Pursuit	81335775	2.50E–01 i					9100 n	910 n	340 n	260000 n	20000 n
Pydrin	51630581	2.50E–02 i					910 n	91 n	34 n	26000 n	2000 n
Pyridine	110861	1.00E–03 i					37 n	3.7 n	1.4 n	1000 n	78 n
Quinalphos	13593038	5.00E–04 i					18 n	1.8 n	0.68 n	510 n	39 n
Quinoline	91225			1.20E+01 h			0.0056 c	0.00052 c	0.00026 c	0.24 c	0.053 c
Resmethrin	10463868	3.00E–02 i					1100 n	110 n	41 n	31000 n	2300 n
Ronnel	299843	5.00E–02 h					1800 n	180 n	68 n	51000 n	3900 n
Rotenone	83794	4.00E–03 i					150 n	15 n	5.4 n	4100 n	310 n
Savey	78587050	2.50E–02 i					910 n	91 n	34 n	26000 n	2000 n
Selenious Acid	7783008	5.00E–03 i					180 n	18 n	6.8 n	5100 n	390 n
Selenium	7782492	5.00E–03 i					180 n	18 n	6.8 n	5100 n	390 n
Selenourea	630104	5.00E–03 h					180 n	18 n	6.8 n	5100 n	390 n
Sethoxydim	74051802	9.00E–02 i					3300 n	330 n	120 n	92000 n	7000 n
Silver and compounds	7440224	5.00E–03 i					180 n	18 n	6.8 n	5100 n	390 n
Simazine	122349	5.00E–03 i		1.20E–01 h			0.56 c	0.052 c	0.026 c	24 c	5.3 c
Sodium azide	26628228	4.00E–03 i					150 n	15 n	5.4 n	4100 n	310 n
Sodium diethyldithiocarbamate	148185	3.00E–02 i		2.70E–01 h			0.25 c	0.023 c	0.012 c	11 c	2.4 c
Sodium [illegible]roacetate	62748	2.00E–05 i					0.73 n	0.073 n	0.027 n	20 n	1.6 n
Sodium [illegible]vanadate	13718268	1.00E–03 h					37 n	3.7 n	1.4 n	1000 n	78 n

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Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	VOC	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Strontium, stable	7440246	6.00E–01 *i*					22000 *n*	2200 *n*	810 *n*	610000 *n*	47000 *n*
Strychnine	57249	3.00E–04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Styrene	100425	2.00E–01 *i*	2.86E–01 *i*			***	1600 *n*	1000 *n*	270 *n*	200000 *n*	16000 *n*
Systhane	88671890	2.50E–02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
2,3,7,8–TCDD (dioxin)	1746016			1.56E+05 *h*	1.16E+05 *h*		4.30E–07 *c*	5.40E–08 *c*	2.00E–08 *c*	0.000018 *c*	4.10E–06 *c*
Tebuthiuron	34014181	7.00E–02 *i*					2600 *n*	260 *n*	95 *n*	72000 *n*	5500 *n*
Temephos	3383968	2.00E–02 *h*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Terbacil	5902512	1.30E–02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
Terbufos	13071799	2.50E–05 *h*					0.91 *n*	0.091 *n*	0.034 *n*	26 *n*	2 *n*
Terbutryn	886500	1.00E–03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
1,2,4,5–Tetrachlorobenzene	95943	3.00E–04 *i*				***	1.8 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
1,1,1,2–Tetrachloroethane	630206	3.00E–02 *i*		2.60E–02 *i*	2.59E–02 *i*	***	0.41 *c*	0.24 *c*	0.12 *c*	110 *c*	25 *c*
1,1,2,2–Tetrachloroethane	79345			2.00E–01 *i*	2.03E–01 *i*	***	0.052 *c*	0.031 *c*	0.016 *c*	14 *c*	3.2 *c*
Tetrachloroethylene (PCE)	127184	1.00E–02 *i*		5.20E–02 *e*	2.03E–03 *e*	***	1.1 *c*	3.1 *c*	0.061 *c*	55 *c*	12 *c*
2,3,4,6–Tetrachlorophenol	58902	3.00E–02 *i*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
p,a,a,a–Tetrachlorotoluene	5216251			2.00E+01 *h*		***	0.00053 *c*	0.00031 *c*	0.00016 *c*	0.14 *c*	0.032 *c*
Tetrachlorovinphos	961115	3.00E–02 *i*		2.40E–02 *h*			2.8 *c*	0.26 *c*	0.13 *c*	120 *c*	27 *c*
Tetraethyldithiopyrophosphate	3689245	5.00E–04 *i*					18 *n*	1.8 *n*	0.68 *n*	510 *n*	39 *n*
Thallic oxide	1314325	7.00E–05 _					2.6 *n*	0.26 *n*	0.095 *n*	72 *n*	5.5 *n*
Thallium											
Thallium acetate	563688	9.00E–05 *i*					3.3 *n*	0.33 *n*	0.12 *n*	92 *n*	7 *n*
Thallium carbonate	6533739	8.00E–05 *i*					2.9 *n*	0.29 *n*	0.11 *n*	82 *n*	6.3 *n*
Thallium chloride	7791120	8.00E–05 *i*					2.9 *n*	0.29 *n*	0.11 *n*	82 *n*	6.3 *n*
Thallium nitrate	10102451	9.00E–05 *i*					3.3 *n*	0.33 *n*	0.12 *n*	92 *n*	7 *n*
Thallium selenite	12039520	9.00E–05 *w*					3.3 *n*	0.33 *n*	0.12 *n*	92 *n*	7 *n*
Thallium sulfate	7446186	8.00E–05 *i*					2.9 *n*	0.29 *n*	0.11 *n*	82 *n*	6.3 *n*
Thiobencarb	28249776	1.00E–02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
2–(Thiocyanomethylthio)–benzothiazole	21564170	3.00E–02 *h*					1100 *n*	110 *n*	41 *n*	31000 *n*	2300 *n*
Thiofanox	39196184	3.00E–04 *h*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Thiophanate–methyl	23564058	8.00E–02 *i*					2900 *n*	290 *n*	110 *n*	82000 *n*	6300 *n*
Thiram	137268	5.00E–03 *i*					180 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
Tin and compounds		6.00E–01 *h*					22000 *n*	2200 *n*	810 *n*	610000 *n*	47000 *n*
Toluene	108883	2.00E–01 *i*	1.14E–01 *w*			***	750 *n*	420 *n*	270 *n*	200000 *n*	16000 *n*
Toluene–2,4–diamine	95807			3.20E+00 *h*			0.021 *c*	0.002 *c*	0.00099 *c*	0.89 *c*	0.2 *c*
Toluene–2,5–diamine	95705	6.00E–01 *h*					22000 *n*	2200 *n*	810 *n*	610000 *n*	47000 *n*
Toluene–2,6–diamine	823405	2.00E–01 *h*					7300 *n*	730 *n*	270 *n*	200000 *n*	16000 *n*
p–Toluidine	106490			1.90E–01 *h*			0.35 *c*	0.033 *c*	0.017 *c*	15 *c*	3.4 *c*
Toxaphene	8001352			1.10E+00 *i*	1.12E+00 *i*		0.061 *c*	0.0056 *c*	0.0029 *c*	2.6 *c*	0.58 *c*
Tralomethrin	66841256	7.50E–03 *i*					270 *n*	27 *n*	10 *n*	7700 *n*	590 *n*
Triallate	2303175	1.30E–02 *i*					470 *n*	47 *n*	18 *n*	13000 *n*	1000 *n*
Triasulfuron	82097505	1.00E–02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
1,2,4–Tribromobenzene	615543	5.00E–03 *i*				***	30 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*

Sources: i=IRIS h=HEAST a=HEAST alt. w=Withdrawn from IRIS or HEAST e=EPA–ECAO o=Other EPA documents *Basis of RBC: c=carcinogenic effects n=noncarcinogenic effects.*

Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	CPSo kg•d/mg	CPSi kg•d/mg	V O C	Tap water µg/L	Ambient air µg/m3	Fish mg/kg	Industrial soil mg/kg	Residential soil mg/kg
Tributyltin oxide (TBTO)	56359	3.00E–05 *i*					1.1 *n*	0.11 *n*	0.041 *n*	31 *n*	2.3 *n*
2,4,6–Trichloroaniline hydrochloride	33663502			2.90E–02 *h*			2.3 *c*	0.22 *c*	0.11 *c*	99 *c*	22 *c*
2,4,6–Trichloroaniline	634935			3.40E–02 *h*			2 *c*	0.18 *c*	0.093 *c*	84 *c*	19 *c*
1,2,4–Trichlorobenzene	120821	1.00E–02 *i*	5.71e–02 *h*			***	190 *n*	210 *n*	14 *n*	10000 *n*	780 *n*
1,1,1–Trichloroethane	71556	9.00E–02 *w*	2.86E–01 *w*			***	1300 *n*	1000 *n*	120 *n*	92000 *n*	7000 *n*
1,1,2–Trichloroethane	79005	4.00E–03 *i*		5.70E–02 *i*	5.60E–02 *i*	***	0.19 *c*	0.11 *c*	0.055 *c*	50 *c*	11 *c*
Trichloroethylene (TCE)	79016	6.00E–03 *e*		1.10E–02 *w*	6.00E–03 *e*	***	1.6 *c*	1 *c*	0.29 *c*	260 *c*	58 *c*
Trichlorofluoromethane	75694	3.00E–01 *i*	2.00E–01 *a*			***	1300 *n*	730 *n*	410 *n*	310000 *n*	23000 *n*
2,4,5–Trichlorophenol	95954	1.00E–01 *i*					3700 *n*	370 *n*	140 *n*	100000 *n*	7800 *n*
2,4,6–Trichlorophenol	88062			1.10E–02 *i*	1.09E–02 *i*		6.1 *c*	0.57 *c*	0.29 *c*	260 *c*	58 *c*
2,4,5–Trichlorophenoxyacetic acid	93765	1.00E–02 *i*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
2–(2,4,5–Trichlorophenoxy)propionic acid	93721	8.00E–03 *i*					290 *n*	29 *n*	11 *n*	8200 *n*	630 *n*
1,1,2–Trichloropropane	598776	5.00E–03 *i*				***	30 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
1,2,3–Trichloropropane	96184	6.00E–03 *i*		7.00e+00 *i*		***	0.0015 *c*	0.00089 *c*	0.00045 *c*	0.41 *c*	0.091 *c*
1,2,3–Trichloropropene	96195	5.00E–03 *h*				***	30 *n*	18 *n*	6.8 *n*	5100 *n*	390 *n*
1,1,2–Trichloro–1,2,2– trifluoroethane	76131	3.00E+01 *i*	8.57E+00 *h*			***	59000 *n*	31000 *n*	41000 *n*	1000000 *n*	1000000 *n*
Tridiphane	58138082	3.00E–03 *i*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
Triethylamine	121448		2.00E–03 *i*				73 *n*	7.3 *n*			
Trifluralin	1582098	7.50E–03 *i*		7.70E–03 *i*			8.7 *c*	0.81 *c*	0.41 *c*	370 *c*	83 *c*
1,2,4–Trimethylbenzene	95636	5.00e–04 *e*				***	3 *n*	1.8 *n*	0.68 *n*	510 *n*	39 *n*
1,3,5–Trimethylbenzene	108678	4.00e–04 *e*				***	2.4 *n*	1.5 *n*	0.54 *n*	410 *n*	31 *n*
Trimethyl phosphate	512561			3.70E–02 *h*			1.8 *c*	0.17 *c*	0.085 *c*	77 *c*	17 *c*
1,3,5–Trinitrobenzene	99354	5.00E–05 *i*					1.8 *n*	0.18 *n*	0.068 *n*	51 *n*	3.9 *n*
Trinitrophenylmethylnitramine	479458	1.00E–02 *h*					370 *n*	37 *n*	14 *n*	10000 *n*	780 *n*
2,4,6–Trinitrotoluene	118967	5.00E–04 *i*		3.00E–02 *i*			2.2 *c*	0.21 *c*	0.11 *c*	95 *c*	21 *c*
Uranium (soluble salts)	7440611	3.00E–03 *i*					110 *n*	11 *n*	4.1 *n*	3100 *n*	230 *n*
Vanadium	7440622	7.00E–03 *h*					260 *n*	26 *n*	9.5 *n*	7200 *n*	550 *n*
Vanadium pentoxide	1314621	9.00E–03 *i*					330 *n*	33 *n*	12 *n*	9200 *n*	700 *n*
Vanadium sulfate	36907423	2.00E–02 *h*					730 *n*	73 *n*	27 *n*	20000 *n*	1600 *n*
Vernam	1929777	1.00E–03 *i*					37 *n*	3.7 *n*	1.4 *n*	1000 *n*	78 *n*
Vinclozolin	50471448	2.50E–02 *i*					910 *n*	91 *n*	34 *n*	26000 *n*	2000 *n*
Vinyl acetate	108054	1.00E+00 *h*	5.71E–02 *i*				37000 *n*	210 *n*	1400 *n*	1000000 *n*	78000 *n*
Vinyl bromide	593602		8.57E–04 *i*			***	5.2 *n*	3.1 *n*			
Vinyl chloride	75014			1.90E+00 *h*	3.00E–01 *h*	***	0.019 *c*	0.021 *c*	0.0017 *c*	1.5 *c*	0.34 *c*
Warfarin	81812	3.00E–04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
m–Xylene	108323	2.00E+00 *h*	2.00E–01 *w*			***	1400 *n*	730 *n*	2700 *n*	1000000 *n*	160000 *n*
o–Xylene	95476	2.00E+00 *h*	2.00E–01 *w*			***	1400 *n*	730 *n*	2700 *n*	1000000 *n*	160000 *n*
p–Xylene	106423		8.57E–02 *w*			***	520 *n*	310 *n*			
Xylene (mixed)	1330207	2.00E+00 *i*				***	12000 *n*	7300 *n*	2700 *n*	1000000 *n*	160000 *n*
Zinc	7440666	3.00E–01 *i*					11000 *n*	1100 *n*	410 *n*	310000 *n*	23000 *n*
Zinc phosphide	1314847	3.00E–04 *i*					11 *n*	1.1 *n*	0.41 *n*	310 *n*	23 *n*
Zineb	12122677	5.00E–02 *i*					1800 *n*	180 *n*	68 *n*	5100	3900 *n*

APPENDIX C
RISK CALCULATIONS FOR FUTURE CONSTRUCTION WORKERS AND FUTURE RESIDENTS

SITE: WPNSTA Yorktown
LOCATION: Yorktown, Va
JOB# 62470-209
DATE: June 3, 1994
DERMAL CONTACT AND INGESTION OF SITE SOILS BY CONSTRUCTION WORKERS.
LOCATION: SURFACE SOILS - MAXIMUM VALUES. ssoila.wk1

PURPOSE: TO ESTIMATE THE ADVERSE HUMAN HEALTH RISKS ASSOCIATED WITH EXPOSURE TO AFFECTED SOILS.
LOGICAL, YET CONSERVATIVE ASSUMPTIONS ARE USED TO DETERMINE THE POTENTIAL RISKS ASSOCIATED WITH DERMAL CONTACT AND INGESTION.
INCREMENTAL CANCER RISKS (ICRs) AND HAZARD INDICES (HIs) ARE PRESENTED IN THE SPREADSHEET.

RELEVANT EQUATIONS:

1. CARCINOGENS

CDI derm = (CS)(SA)(AD)(ABS)(EF)(ED)(CF)/(BW)(AT)

WHERE: CS = THE CHEMICAL CONCENTRATION (mg/Kg)
SA = THE EXPOSED SURFACE AREA OF THE SKIN (cm^2)
AD = THE DERMAL ADHERENCE CONSTANT (mg/cm^2 d)
ABS = THE ABSORBED FRACTION (unitless)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (years)
CF = CONVERSION FACTOR (10^-6 Kg/mg)
BW = THE AVERAGE RECEPTOR BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (70yrs x 365d/yr)

CDI ing = (CS)(IR)(CF)(EF)(ED)/(BW)(AT)

WHERE: CS = THE CONCENTRATION IN SOIL (mg/Kg)
CF = THE CONVERSION FACTOR (10^-6 Kg/mg)
IR = THE INGESTION RATE (mg/d)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (yr)
BW = BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (70yrs x 365d/yr)

ICR = SUM(ICRi * CPFi) (linear)

TOTAL ICR = ICR derm + ICR ing

2. NONCARCINOGENS

CDI derm = (CS)(SA)(AD)(ABS)(EF)(ED)(CF)/(BW)(AT)

WHERE: CS = THE CHEMICAL CONCENTRATION (mg/Kg)
SA = THE EXPOSED SURFACE AREA OF THE SKIN (cm^2)
AD = THE DERMAL ADHERENCE CONSTANT (mg/cm^2 d)
ABS = THE ABSORBED FRACTION (unitless)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (years)
CF = CONVERSION FACTOR (10^-6 Kg/mg)
BW = THE AVERAGE RECEPTOR BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (ED x 365d/yr)

CDI ing = (CS)(IR)(CF)(EF)(ED)/(BW)(AT)

WHERE: CS = THE CONCENTRATION IN SOIL (mg/Kg)
CF = THE CONVERSION FACTOR (10^-6 Kg/mg)
IR = THE INGESTION RATE (mg/d)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (yr)
BW = BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (ED x 365d/yr)

HAZARD INDEX = SUM(DOSEi / RfDi)

TOTAL HI = HI derm + HI ing

SITE: WPNSTA Yorktown
LOCATION: Yorktown, Va
JOB # 62470-209
DATE: June 3, 1994
DERMAL CONTACT AND INGESTION OF SITE SOILS BY CONSTRUCTION WORKERS
LOCATION: SURFACE SOILS - MAXIMUM VALUES

CONSTITUENTS	CS (mg/Kg)	AD (mg/cm^2 d)	CF (10^-6 Kg/mg)	SA (cm^2)	EF (d/yr)	ED (yrs)	ABS*
PCB-1260	1.4	1	1.00E-06	5300	250	25	0.01
DERMAL CONTACT TOTAL							

CONSTITUENTS	CS (mg/Kg)	IR (mg/d)	EF (d/yr)	ED (yr)	BW (Kg)	AT Carc. (d)	AT Ncarc. (d)
PCB-1260	1.4	100	250	25	70	25550	9125
INGESTION TOTAL							
TOTAL							

* Absorption Factor of 0.01 (or 1%) used because the organic carbon content of the soil is the normal range (between 0.8% and 1%). Aroclor-1260 is more likely to bind to soil rather than be absorbed by the human skin.

SITE: WPNSTA Yorktown
LOCATION: Yorktown, Va
JOB # 62470-209
DATE: June 3, 1994
DERMAL CONTACT AND INGESTION OF SITE SOILS BY CONSTRUCTION WORKERS
LOCATION: SURFACE SOILS - MAXIMUM VALUES

CONSTITUENTS	BW (Kg)	AT CARC. (d)	AT NCARC. (d)	DERMAL CARC. DOSE	DERMAL NONCARC. DOSE	CPF (Kg-d/mg)
PCB-1260	70	25550	9125	2.59E-07	7.26E-07	7.7
DERMAL CONTACT TOTAL						

CONSTITUENTS	INGESTION CARC. DOSE	INGESTION NONCARC. DOSE	CPF	RfD	INGESTION ICR	INGESTION HI
PCB-1260	4.89E-07	1.37E-06	7.7		3.77E-06	0.00E+00
INGESTION TOTAL					3.77E-06	0.00E+00
TOTAL					5.76E-06	

SITE: WPNSTA Yorktown
LOCATION: Yorktown, Va
JOB # 62470-209
DATE: June 3, 1994
DERMAL CONTACT AND INGESTION OF SITE SOILS BY CONSTRUCTION WORKERS
LOCATION: SURFACE SOILS - MAXIMUM VALUES

CONSTITUENTS	RfD (mg/Kg-d)	DERMAL ICR	DERMAL HI	PERCENT CARC. RISK	PERCENT HAZARD INDEX	EPA WEIGHT OF EVIDENCE
PCB-1260		2.00E-06	0.00E+00	100.00	0.00	B2
DERMAL CONTACT TOTAL		2.00E-06	0.00E+00	100	0	

CONSTITUENTS	Percent Carc. Risk	Percent Ncarc. Risk	COMMENTS
PCB-1260	100.00	0.00	No dermal adjustment to the CSF
INGESTION TOTAL	100	0	
TOTAL			

SITE: WPNSTA Yorktown
LOCATION: Yorktown, Va
JOB# 62470-209
DATE: June 3, 1994
DERMAL CONTACT AND INGESTION OF SITE SOILS BY FUTURE RESIDENTS.
LOCATION: SURFACE SOILS - MAXIMUM VALUES. ssoila.wk1

PURPOSE: TO ESTIMATE THE ADVERSE HUMAN HEALTH RISKS ASSOCIATED WITH EXPOSURE TO AFFECTED SOILS.
LOGICAL, YET CONSERVATIVE ASSUMPTIONS ARE USED TO DETERMINE THE POTENTIAL RISKS ASSOCIATED WITH DERMAL CONTACT AND INGESTION.
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1. CARCINOGENS

CDI derm = (CS)(SA)(AD)(ABS)(EF)(ED)(CF)/(BW)(AT)

WHERE: CS = THE CHEMICAL CONCENTRATION (mg/Kg)
SA = THE EXPOSED SURFACE AREA OF THE SKIN (cm^2)
AD = THE DERMAL ADHERENCE CONSTANT (mg/cm^2 d)
ABS = THE ABSORBED FRACTION (unitless)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (years)
CF = CONVERSION FACTOR (10^-6 Kg/mg)
BW = THE AVERAGE RECEPTOR BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (70yrs x 365d/yr)

CDI ing = (CS)(IR)(CF)(EF)(ED)/(BW)(AT)

WHERE: CS = THE CONCENTRATION IN SOIL (mg/Kg)
CF = THE CONVERSION FACTOR (10^-6 Kg/mg)
IR = THE INGESTION RATE (mg/d)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (yr)
BW = BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (70yrs x 365d/yr)

ICR = SUM(ICRi * CPFi) (linear)

TOTAL ICR = ICR derm + ICR ing

2. NONCARCINOGENS

CDI derm = (CS)(SA)(AD)(ABS)(EF)(ED)(CF)/(BW)(AT)

WHERE: CS = THE CHEMICAL CONCENTRATION (mg/Kg)
SA = THE EXPOSED SURFACE AREA OF THE SKIN (cm^2)
AD = THE DERMAL ADHERENCE CONSTANT (mg/cm^2 d)
ABS = THE ABSORBED FRACTION (unitless)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (years)
CF = CONVERSION FACTOR (10^-6 Kg/mg)
BW = THE AVERAGE RECEPTOR BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (ED x 365d/yr)

CDI ing = (CS)(IR)(CF)(EF)(ED)/(BW)(AT)

WHERE: CS = THE CONCENTRATION IN SOIL (mg/Kg)
CF = THE CONVERSION FACTOR (10^-6 Kg/mg)
IR = THE INGESTION RATE (mg/d)
EF = THE EXPOSURE FREQUENCY (d/yr)
ED = THE EXPOSURE DURATION (yr)
BW = BODY WEIGHT (Kg)
AT = THE AVERAGING TIME (ED x 365d/yr)

HAZARD INDEX = SUM(DOSEi / RfDi)

TOTAL HI = HI derm + HI ing

SITE: WPNSTA Yorktown
LOCATION: Yorktown, Va
JOB # 62470-209
DATE: June 3, 1994

DERMAL CONTACT AND INGESTION OF SITE SOILS BY FUTURE RESIDENTS
LOCATION: SURFACE SOILS - MAXIMUM VALUES

CONSTITUENTS	CS (mg/Kg)	AD (mg/cm^2 d)	CF (10^-6 Kg/mg)	SA (cm^2)	EF (d/yr)	ED (yrs)	ABS*
PCB-1260	1.4	1	1.00E-06	5300	350	30	0.01
DERMAL CONTACT TOTAL							

CONSTITUENTS	CS (mg/Kg)	IR (mg/d)	EF (d/yr)	ED (yr)	BW (Kg)	AT Carc. (d)	AT Ncarc. (d)
PCB-1260	1.4	100	350	30	70	25550	10950
INGESTION TOTAL							
TOTAL							

* Absorption Factor of 0.01 (or 1%) used because the organic carbon content of the soil is the normal range (between 0.8% and 1%). Aroclor-1260 is more likely to bind to soil rather than be absorbed by the human skin.

SITE: WPNSTA Yorktown
LOCATION: Yorktown, Va
JOB # 62470-209
DATE: June 3, 1994
DERMAL CONTACT AND INGESTION OF SITE SOILS BY FUTURE RESIDENTS
LOCATION: SURFACE SOILS - MAXIMUM VALUES

CONSTITUENTS	BW (Kg)	AT CARC. (d)	AT NCARC. (d)	DERMAL CARC. DOSE	DERMAL NONCARC. DOSE	CPF (Kg-d/mg)
PCB-1260	70	25550	10950	4.36E-07	1.02E-06	7.7
DERMAL CONTACT TOTAL						

CONSTITUENTS	INGESTION CARC. DOSE	INGESTION NONCARC. DOSE	CPF	RfD	INGESTION ICR	INGESTION HI
PCB-1260	8.22E-07	1.92E-06	7.7		6.33E-06	0.00E+00
INGESTION TOTAL					6.33E-06	0.00E+00
TOTAL					9.68E-06	

SITE: WPNSTA Yorktown
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DERMAL CONTACT AND INGESTION OF SITE SOILS BY FUTURE RESIDENTS
LOCATION: SURFACE SOILS - MAXIMUM VALUES

CONSTITUENTS	RfD (mg/Kg-d)	DERMAL ICR	DERMAL HI	PERCENT CARC. RISK	PERCENT HAZARD INDEX	EPA WEIGHT OF EVIDENCE
PCB-1260		3.35E-06	0.00E+00	100.00	0.00	B2
DERMAL CONTACT TOTAL		3.35E-06	0.00E+00	100	0	

CONSTITUENTS	Percent Carc. Risk	Percent Ncarc. Risk	COMMENTS
PCB-1260	100.00	0.00	No dermal adjustment to the CSF
INGESTION TOTAL	100	0	
TOTAL			